UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TELEPHONE HANDBOOK

PREPARED BY
UNIVERSITY OF MONTANA

VF
05
0261

LIBRARY FILE COPY
Rocky Mountain Research Station

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

LYLE F. WATTS, CHIEF

TELEPHONE HANDBOOK

APRIL 1947

CONTENTS

POLICY, COMMUNICATION

Section		Page
1.	General statement of policy	1
2.	Regional and forest communication organization	2
3.	Minimum planning requirements	3
4.	Metallic vs. ground-return construction	5
5.	Integration of communication methods	5
6.	Construction and abandonment of communication facilities	6
7.	Adherence to standards	6
8.	Retaining the communication plan objective	7
9.	Authorized use of radio	7
10.	Lending of radio equipment to other agencies	8
11.	Restrictions of power output of transmitters	8
12.	Assignment and use of radio frequencies	8
13.	Centralization of technical development	9
14.	Right-of-way agreements and easements	9
15.	Location of lines in relation to esthetic values	10
16.	Charges for facilities use	11
17.	Commercial use of national forests affecting communication	12
18.	Cooperation in communications with State and private forestry and Federal protection agencies	12

PLANNING COMMUNICATIONS

19.	General	13
20.	Field study	13
21.	Determination of possible future boundary changes	14
22.	Determination of possible future headquarters	14
23.	Determination of possible routes	15
24.	Consideration of planning data	15
25.	Preparation of plan	17
26.	Working plans	18
27.	Rights-of-way	19
28.	Preliminary survey	20
29.	Line location, pole	21
30.	Survey procedure	22
31.	Working up the survey notes	23
32.	Transpositions	24
33.	Transposition, records for construction	25
34.	Line location, tree	25
35.	Material and cost estimates	25
36.	Labor cost and time estimates	25
37.	Recurrent costs other than maintenance	26
38.	Switchboard diagrams	26

Section		Page
39.	Terminal and distribution diagrams	26
40.	Letters of instruction	26
41.	Data folder	28
	CONSTRUCTION (TREE LINES)	
42.	General	30
43.	Locating tree lines	30
44.	Selection of tie trees	33
45.	Use of poles in tree lines	33
46.	Tripods and cribs	34
47.	Span lengths, normal spans	35
48.	Span length, long spans	36
49.	Stringing wire	37
50.	Ties	37
51.	Hanging wire	39
52.	Splicing line wire	41
53.	Sag or slack	41
54.	Downhill grade snubbing	41
55.	Clearing	43
56.	Brush disposal	43
57.	Size of crew	44
58.	Lightning protection	44
59.	Tools required for tree-line construction	45
60.	Materials required for average mile tree line	45
	CONSTRUCTION (POLE LINES)	
61.	General	46
62.	Planning the construction job	46
63.	Clearing	47
64.	Brush disposal	48
65.	Span lengths, pole lines	48
66.	Extra long spans (metallic circuits)	49
67.	Short spans in extreme loading areas	49
68.	Holes, poles	49
69.	Anchor holes	51
70.	Anchors--log and plank	51
71.	Anchors--cone or steelwing	52
72.	Anchors--rock	54
	POLES	
73.	Handling and delivery of poles	55
74.	Creosote burns	55
75.	Trucking poles	56
76.	Loading poles on truck-trailer combine	56

Section		Page
77.	Unloading poles from truck-trailer	57
78.	Unloading poles at railroad sidings	57
79.	General precautions when unloading poles	59
80.	Unloading flat cars	60
81.	Stacking poles	63
82.	Expansions, future	65
83.	Permanent systems	66
84.	Temporary systems	66
85.	Pole use	66
86.	Distribution of poles	67
87.	Steel poles	68
88.	Stubbing	68
89.	Splicing poles	70
90.	Framing poles	70
91.	Pole grading, vertical alignment	71
92.	Poles--erecting (hand)	72
93.	Tools required for raising poles by hand	74
94.	Erecting poles (with gin pole)	74
95.	Poles, setting (with the water-jet method)	77
96.	Rake of corner poles	78
97.	Backfilling and tamping	79
98.	Pole, facing	80

ATTACHMENTS, POLES

99.	Crossarms	83
100.	Double crossarms	86
101.	Extension (alley) arms	87
102.	Arms, reverse (buck)	90
103.	H-fixtures	92
104.	Brackets	95
105.	Braces, push pole	99
106.	Guying	102
107.	Guy shields--(guards)	108
108.	Pole dating	108
109.	Pole painting	108
110.	Stepping	108
111.	Pole numbering	110
112.	Pole protection grounds	111
113.	Braces, crossarm	113
114.	Pins	113
115.	Insulators	113
116.	Insulator placing	114
117.	Stringing wire	115

Section | Page

CROSSINGS AND CLEARANCES

118. Placing wires on poles 118
119. Streets, highways, roads, over 121
120. Railroads, over 121
121. Waterways, over 121
122. Over power, trolley, or light wires 124
123. Crossing under power lines 125
124. Joint use and parallel to power wires 126
125. Pulling slack 128
126. Splicing and connecting line wires 129
127. Sags 134
128. Conductor loading 136
129. Transposition 143
130. Transpositions, Rl 145
131. Tying Rl transposed lines 148
132. Mounting transpositions on tandem brackets..... 149
133. Transpositions, phantom 150
134. Tying line wires 156
135. Ties, general 157
136. Dead-ending wires 163
137. Dead-ending line wire 164
138. Test stations 165

CONSTRUCTION, ENTRANCE AND DISTRIBUTION LINES

139. Planning and layout 166
140. Selecting the route for the overhead cable system 168
141. Overhead construction 168
142. Selecting and listing of material 170
143. Erecting the poles and messenger cables 170
144. Installing the rings and drop wire on the messenger 171
145. Connection of drop wires at terminals and junctions 173

TERMINAL STRIPS AND CABINETS

146. General 177
147. Outside terminal junctions 177
148. Inside terminal junctions 178
149. Entrance construction, buildings 180
150. Reducing sleeves 184
151. Tap sleeves 185
152. Splicing drop, bridle, and inside wire 185
153. Entrance construction--heavy loading 187
154. Entrance construction--light loading 187
154-A. Underground construction 191

Section | Page

GROUNDING SYSTEMS

155. Grounding systems, general 194
156. Practical grounding systems 195
157. Metallic objects suitable for grounding 196
158. Water systems 196
159. Caution 196
160. Sewage systems 197
161. Culverts 197
162. Other large area metallic objects 197
163. Freezing of grounds 197
164. Multiple rods 198
165. Chemical treatment 199
166. Testing grounds 200

LINE AND PLANT PROTECTION SYSTEM

166-A. General 202
167. Pole protection grounds 202
168. Line and instrument protection 203
169. Ball-gap arresters 203
170. Grounding conductor for gap arresters 205
171. Grounds for gap arresters 208
172. Carbon block-type arresters 208
173. Vacuum-type arresters 209, 300
174. Grounding-type disconnect switches 209
174-A. Line and instrument disconnects 212
174-B. Line fuses 212
176. Protector #99-A 213

MISCELLANEOUS ITEMS

177. Line loading 215
178. Wire 216
179. Galvanized iron--No. 9 E.B.B. 216
180. Solid hard drawn copper wire 216
181. Copper-covered steel wire 217
182. Switchboards, general 218

TELEPHONE INSTRUMENTS

183. General 218
184. Power ringing equipment 220
185. Centralized repair of telephone equipment 220
186. Repeating coils 220
187. Tests--repeating coils 221
188. Methods of testing repeating coils before placing in use ... 223

Section | Page

189. Tests--transmission 225
190. Batteries (dry cells 1-1/2 volt) 225

MATERIALS

190. General 226

MAINTENANCE TELEPHONE CIRCUITS

191. General 265
192. Tree lines 265
193. Pole lines 267
194. Circuit noise 268
195. Longitudinal unbalance in line conductors 270
196. Contact with other conductors 270
197. Unbalance due to improper transpositions 271
198. Cross-talk on metallic systems 271
199. Noise on ground-return lines 271
200. Repair sleeves for line wire 272
201. Telephone instrument maintenance 273

MAINTENANCE STORAGE TOOLS EQUIPMENT--CARE OF SPECIAL EQUIPMENT

202. Climbers, lineman's 277
203. Sharpening gaffs 277
204. Precautions 278
205. Body belt and safety strap 278
206. Maintenance 281
207. Storage and preservation 283
208. General precautions 283
209. Adjustment of compression tools 284, 285

MANUFACTURER EQUIPMENT AND SUPPLIES 286, 287

TOOLS ..... 288 - 295

EASEMENT FORMS ..... 296 - 299

APPENDIX ..... 301 - 314

INDEX OF ILLUSTRATIONS 315

INDEX OF HANDBOOK 322

1. General Statement of Policy

(extracted from Forest Service Manual
National Forest Protection and Management)

The communication system on each National Forest unit should be developed and maintained in accordance with plans which are coordinated and consistent with the objectives and standards of both Forest administration and protection. The system should not be "overbuilt", nor should it be "underbuilt", but must be sufficient to fit a planned level of quality, use, and reliability.

Duplication of wire facilities to obtain the same service, where commercial or private telephone lines are available and satisfactory, should not be considered. Point-to-point radio and telephone facilities should not be duplicated to obtain the same service.

Radio has been developed to a satisfactory level of reliability and should, as a rule, be used in lieu of telephone at isolated points and in back country where extensive telephone lines are otherwise needed for seasonal communication only. Very high frequency (VHF) radio will fit well into a local communication system of point-to-point service. Its uses can be greatly increased by remote connections with the telephone system.

It should be understood that under most topographic conditions, very high frequency has real possibility for effective use in small communication networks involving districts and often adjoining forests particularly where a need exists for the use of portable and mobile equipment. Continuous laboratory experimentation and thorough field trials are essential to the realization of full value from this type of equipment.

Responsible officers assigned to administration and protection where effective communications is a vital factor are expected to be alert and responsive to rapidly advancing thought and development in the communications field. The necessity for an open-minded and progressive approach to this important phase of public land management should be clearly evident.

Installation of new radio equipment will be limited to F.M. (Frequency Modulation) gear, except where A.M. (Amplitude Modulation) equipment is necessary to work with an existing A.M. network and such equipment cannot be secured by transfer

from another Forest or Region. All such equipment purchases must be cleared with the Radio Laboratory.

The primary objective of communication planning, construction and maintenance will be to create a stabilized communication system having maximum reliability with a minimum of technical complications. Wherever possible, use radio to lower the initial investment and annual maintenance charge. Sufficient records and data will be maintained of all types of communication facilities used under various conditions to enable responsible officers to make prompt and intelligent decisions whenever additional facilities are proposed for installation.

2. Regional and Forest Communication Organization

(a) Regional Communications Committee

The Regional Foresters will designate either the Division of Engineering or the Division of Operation as being responsible for communications in the Region.

Each Region will maintain a Regional Communications Committee made up of representatives of the principal communication-using Divisions. The representative of the Division responsible for communications will serve as Chairman of this Committee.

The Committee will function as a reviewing body for all communication plans and will recommend such plans to the Regional Forester for acceptance or rejection, based on Region-wide plan coordination, necessity, financing, and consideration of alternative methods. An important phase of the job assigned to this group is to establish and maintain communications planning on a sound long-range basis.

The Forest Supervisor will forward to the Regional Communications Committee all, except strictly temporary, proposals for construction or alterations involving deviations from the approved Forest communication plan. These proposals, together with the communication plan, will be considered and appropriate recommendations made to the Regional Forester.

(b) Regional Communications Officer

Each Region should have a qualified person to serve as its Communications Officer, and he should be assigned to the Division responsible for communication in the Region. This man should be familiar with Forest administrative work and have the necessary technical knowledge of communication systems, both radio and wire. This position should serve as a centralized coordinating point for plan preparation, execution, compliance, and modification.

The occupant of this position will also provide overall technical supervision of telephone construction and maintenance programs and of radio installation, maintenance, and operator training programs. He will also act as the technical advisor to the Regional Communications Committee.

(c) Forest Communications Officer

Those Forests which have sufficient telephone mileage and numbers of radiophones (as determined by job-load analysis) should have a combination telephone-radio technician. It will be the duty of such a technician to correct technical faults and maintain the radio and telephone system, including radio equipment repair, repair and testing of repeat coils, grounds, transpositions, keys, jacks, and plugs on switchboards, lightning protection installations, installations of all instruments, phantom and control circuits, and to make instrument tests to determine line performance and locate line failure and faults. He should also take a leading part in communication planning.

In instances where an individual Forest does not require a full-time technician, one such officer should be assigned to two or more such Forests.

3. Minimum Planning Requirements

Planning of a communication system is essential for economical and satisfactory development and service. Accordingly, no expansions or reductions in the telephone or radio system should be made without coordinating such action with the overall plan and objectives.

Planning should reflect the judgment and experience of Forest personnel and Regional Division Chiefs concerned with use,

maintenance, and financing of the communication system. Its implementation and technical design should be accomplished by an officer competent in this specialized field.

The required minimum elements of communication planning shall include:

(a) A complete inventory of the existing communication plant in the form of maps supplemented by written material. This will include an accurate record of existing line mileages by types (grounded or metallic);

(1) Radio installations; Inventory of Radio installation needs and present use.

(2) General condition of pole, wire, instruments, hardware, switchboards, and radio equipment;

(3) Contracts and agreements in effect;

(4) Pertinent data on other-agency or commercial telephone, radio, telegraph and power facilities in or adjacent to the area, and degree of use made of such facilities by the Forest Service (actual and probable)

(b) Broad consideration of the communication problem at both Regional and Forest levels. Such consideration should bring out answers to the following and similar questions:

(1) Why is the proposed facility necessary?

(2) Where should the facility be located to meet the greatest number of current and anticipated future needs and to permit maximum flexibility and minimum reconstruction and changes in fire control methods, transportation systems, and administrative organization?

(3) Is the proposal coordinated with other Forest and Regional plans?

(4) Is the proposal coordinated with facilities of other agencies?

(5) Is the communication to be provided seasonal or full-time, and how important is it to have uninterrupted service?

(c) Cost estimates with statements of justification for improvement, revision, or expansion and anticipated maintenance cost, in written form.

(d) Coordination of inventory data with the requirements set forth in the approved proposal as a basis for developing the plan.

(e) Regional Communications Committee's review and recommendations to the Regional Forester in steps C. and D.

4. Metallic vs. Ground-Return Construction

Ground-return telephone lines will be standard except where, for justifiable reason, electrical or otherwise, they are not practicable.

Studies, including tests for interference, should be made of each route being considered for ground-return construction. Power companies and cooperatives may have plans to install interference structures near the selected route. Such operators should be consulted for the purpose of determining their plans.

Neither ground nor metallic telephone lines, except distribution lines at Forest Service stations, where power does not exceed 220 volts, should be constructed on the same right-of-way as a power facility. In places where such installations have been made, location of the telephone line will be changed only if required to provide satisfactory service.

5. Integration of Communication Methods

Whenever conditions offer alternative methods of communication a thorough investigation will be undertaken preparatory to initial planning or to the revamping of existing plans. It will be the direct responsibility of field officers to present a thorough analysis of administrative requirements with concise recommendations in accordance with their best judgment. The Region will arrange either through the laboratory or by employing competent personnel with specialized communications training to make the necessary determinations as to technical limitations which may be involved.

If the analysis clearly indicates the advisability of wire service, the possibility of utilizing commercial or other existing facilities should be carefully weighed. Wherever practicable, commercial installations should be used since the cost of such service is often less than the required construction investment and the recurrent cost of maintenance.

The development of specialized radio equipment has reached a point where there can be no reasonable doubt as to its thorough reliability. In this connection, however, it is important to recognize that a wide variety of equipment has been designed to meet specific needs and unless competent selection of equipment is made, erroneous judgment of performance standards may easily result. It is not sound practice to duplicate communication service with two methods as has often been done with wire and radio. The weight of advantage will rest with one or the other which if properly developed will offer maximum reliability. This single method requirement is not intended to discourage the installation of radio at certain telephone equipped stations to provide an extension of communication to further points. Actually the intelligent integration of the two facilities will often be required to obtain essential coverage in a communications network.

6. Construction and Abandonment of Communication Facilities

There shall be no new construction, or abandonment of existing telephone facilities, without first coordinating such action with the communication plan through concurrence of the Forest Supervisor and Regional Communications Committee, subject, of course, to final decision by the Regional Forester.

Additions or removals of instruments, switchboards, and lines shall be reported currently through the Forest Supervisor to the Regional Communications Officer. This procedure is essential to the current maintenance of communication plans and records and to prevent deterioration of a planned system through cumulative loading and eventual loss of satisfactory service.

The only exception to this policy will exist where additions or removals are of a strictly temporary nature and the system is to be restored to original condition upon termination of the emergency.

New installations and relocation of permanent or semi-permanent radio installations shall be reported in a similar manner in order to maintain planned coordination of wire and radio communications.

7. Adherence to Standards

Inspection of communication service and facilities will be made on the basis of the standards and practices set forth in the Telephone and Radio Handbooks. New work and reconstruction should follow these instructions and existing facilities should be gradually brought up to standard during the process of maintenance by adoption of the prescribed practices.

Any communication facility, the retention of which is justified, should be so maintained as to insure adequate and reliable service.

Inspection should include a check for the practice of unauthorized local experimentation and the resulting introduction of non-standard procedures and equipment. Special needs not met by existing equipment or standards should be handled as set forth in the statement on "Centralization of Technical Development".

8. Retaining the Communication Plan Objective

Where the actual construction proposed in communication plans is to be delayed or carried out as several separate jobs extending over a period of years, it is essential that the objectives of the plan be kept in mind during the interim periods.

When the period between planning and execution is prolonged, the tendency exists to lose sight of the plan through accumulation of so-called "emergency construction". In such cases, the plan becomes meaningless before construction is completed, and the planning time and costs are wasted. Adherence to the Regional Committee organization and the current recording of all changes by the Regional Communications Officer, as set forth in "Construction and Abandonment", will help to prevent loss of objective.

9. Authorized use of Radio

There are no administrative restrictions prohibiting the use of very high frequency (30-300 megacycles) (VHF) radio for all-purpose National Forest communications, other than the "non-paralleling" requirements set up in "Integration of Methods of Communication". Since the basic use of radio in the Forest Service is related to fire activities, it is essential that frequencies in the vicinity of 3000 kc (2000 to 4000 kc) be assigned primarily for emergency communications. An established administrative communication network occupying one of these frequencies reduces or nullifies the value of such a frequency for emergency use, not only locally but inter-Forest and frequently inter-Regionally since the channel is apt to be "plugged" by general communications when other units are in urgent need of it for fire or similar emergencies. However, use of these frequencies for other than emergency communication will be authorized providing such use is restricted to those periods of the year when interference (inter-Regionally) of fire communication will not occur, and under conditions where frequencies are so distributed as to insure non-interference with other units,

particularly in adjoining Regions.

10. Lending of Radio Equipment to Other Agencies

Radio equipment may not be lent to other departments or agencies for communication use on frequencies assigned to the Department of Agriculture, since a loan would, in effect, constitute the assignment of a radio-operating frequency to the borrowing agency. Such assignments can be made only by the Federal Communications Commission (FCC) or the Interdepartmental Radio Advisory Committee (IRAC).

In an emergency, the Forest Service may be called upon to furnish valuable service to a public agency by providing radio communication. Under these conditions, radio equipment may be lent for a limited, temporary period, but it should, wherever possible, remain under the immediate supervision of a Forest officer. Loan of equipment should not be made in any instance where Forest Service and other public interests may be jeopardized.

11. Restrictions on Power Output of Transmitters

Power output of Forest Service radio transmitters will not, in any instance, be greater than is necessary to afford reliable and satisfactory communication. Power output shall not exceed the maximum limits specified below, except when specifically authorized by the Chief:

MF	(medium frequency 300-3000 KC)	25 watts
HF	(high frequency 3000-30000 KC)	25 watts
VHF	(very high frequency 30-300 MC)	25 watts

Where special communication problems involving the use of frequencies between 30 and 100 MC can be met only by use of power greater than 25 watts, such problems, together with justification and pertinent technical data, shall be submitted to the Chief for approval and to serve as a basis to obtain authorization to increase power. For point-to-point service on frequencies above 100 megacycles, the power shall be limited to that necessary to obtain reliable communication, but may exceed 25 watts upon specific authorization from the Chief if directional antennas are used and interference is not created with established radio services.

12. Assignment and Use of Radio Frequencies

Radio frequencies assigned to the Department of Agriculture

for use by the Forest Service are necessarily limited in number due to the intensive use of the radio spectrum by the thousands of domestic and international services requiring radio communication. It is imperative, therefore, that the maximum-use value be received from each such assignment and that Service-wide compliance be observed in matters of domestic and international radio regulations.

Maximum-use value can be secured only by over-all coordination of the distribution of frequency assignments to Regions and Forests. This is necessary to prevent inter-Regional frequency conflicts and the development of intolerable interference.

Each Region will prepare and maintain currently a radio frequency inventory and needs proposal, based on a coordinated communication plan, and furnish a copy to the Chief. This material will be consolidated into a general all-service plan and individual Regional requests for assignments will be granted to the extent that all-Service coordination will permit and still retain consistency with the established plan.

Requests for frequency assignments should be specific in listing the location and type (SPF, SX, T, M, etc.) of instruments and the desired frequencies for use at each location. The request should also include a statement covering the general and special uses to be made of the desired frequencies. Portable sets, except those to be used as fixed station, will be reported by Forests only.

13. Centralization of Technical Development

The justification for centralized control of technical developments, generally, has been adequately confirmed. Accordingly, the development, modification, and adaptation of radio equipment will remain in the Radio Laboratory.

Problems involving materials or methods not specifically covered in the Telephone Handbook shall be submitted to the Chief for consideration and final determination. Technical radio problems will be referred to the Radio Laboratory at Portland directly, except where the problem will require travel from the Laboratory, in which case it will be submitted to the Chief.

14. Right-of-way Agreements and Easements

A right-of-way agreement or permit is necessary for all telephone lines not on National Forest land. In some states, it is permissible to use road or highway rights-of-way,

through contact with the proper county or state official. In other states, private property rights extend to the center line of the road or highway right-of-way. Where this condition exists, it is necessary that rights-of-way for the line be secured from landowners and permission to occupy a part of the road right-of-way secured from the state or county officer authorized to issue such permits.

Rights-of-way from private owners should be complete in detail. In most cases the right-of-way should be secured as an easement. The form of acknowledgment should be the same as that commonly used in the applicable state. The legal recording of such instruments is not required, but is considered good business. A sample form acceptable to the Solicitor is included in the appendix.

Rights-of-way over railroad property usually require railroad stipulations, some of which are not acceptable to a Government agency due to statutory restrictions imposed by Congress. A sample form is included in the appendix. This form has the approval of the Solicitor; therefore, any changes which may be necessary to comply with railroad requirements should be reviewed by the Regional Attorney before final execution.

Rights-of-way over public land, administered by another agency, will be handled as an agreement or by an exchange of letters between the proper administrative officials.

Rights-of-way over navigable waterways should be secured from the proper agency, usually the War Department.

15. Location of Lines in Relation to Esthetic Values

Telephone-line construction, in or along areas having esthetic values, should be well planned to avoid destroying or depreciating such values. This will be an objective which should be considered of equal importance with that of constructing the line itself.

Locators of either tree or pole lines can frequently achieve these two common objectives by various devices such as long spans and good engineering. There may be a need, on occasion, to do some supplemental planting to screen out poles and wires. Where this is necessary, it should be accomplished promptly following line construction.

Within roadside zones which have been designed for their scenic value, telephone-line construction should not be permitted without prior approval of the Regional Forester or Chief, as the case may be. Where telephone service is

necessary through or along such zones, the lines should be well removed and screened from the road. Frequently commercial wires are available, in which case either circuit or pin space should be rented. The scenic values of such zones are often spotty and of short length, and complete removal of the facilities from within sight of the road need be effected only through the actual scenic areas of such zones.

In order to avoid failures common to underground construction, telephone lines at Ranger and other Forest Service stations should be kept overhead wherever possible. Esthetic values can often be preserved by bringing the lines through a carefully selected location, usually in the rear of the building or buildings. Landscaping will, in many instances, successfully screen out the construction.

In primitive or natural areas, radio should ordinarily be used in lieu of the telephone. Where that is not practicable, tree-line construction should be used and right-of-way clearing held to a minimum.

16. Charges for Facilities Use

Permission will not be granted by the Forest Service to individuals, groups, companies, or agencies, to attach wire, crossarms, brackets, or any facility, to Forest Service poles without approval by the Regional Forester. His consideration should be based upon adequate data, taken from the communication plan, correlated with the indicated needs of the Forest Service. He should also consider state laws covering telephone-line construction, the purpose for which the request is made, and the benefits and disadvantages which may accrue to Forest Service facilities and needs if the permit is granted. The maintenance plan of the facility, and the financial integrity of those responsible for compliance with the plans, should also be given consideration. These requirements are made to assure the Forest Service of the continued and unimpaired use of its facilities.

Cooperation involving joint ownership, construction, or maintenance of telephone lines introduces a division of responsibility which may affect communication and maintenance as well as future growth and extensions. Such cooperation will not be entered into except in unusual instances, and then only with the specific approval of the Regional Forester.

Except where National or Regional contracts apply, Forest Service contacts on commercial or privately owned telephone poles will be paid for at the stated tariff rate of the company or individual, unless local conditions require special treatment.

Company or individual contacts on Forest Service poles will be paid for at rates in accordance with current National or Regional contracts, reciprocal rates, or at the regular tariff rates of the commercial company operating in the territory.

17. Commercial Use of National Forests Affecting Communication

Special-use permits for commercial or other-agency radio transmitter station, testing station, and experimental laboratory sites, and applications for communication or power-line rights-of-way where such permits are regularly handled by the Forest Service, shall be reviewed by the Communications Committees for determination of possible effects on existing and proposed Forest Service communication facilities prior to issuance of such permits. Non-interference clauses should be uniformly included as added protection of Forest Service networks.

18. Cooperation in Communications with State and Private Forestry and Federal Protection Agencies

The communications work of State and Private Forestry and Federal forest protection agencies ties into the work of the Forest Service through the common purpose of forest protection programs and conservation in general.

Where well-established state forestry communication systems do not exist but are needed, the Forest Service should offer guidance and assistance in developing planned systems, including technical advice and arrangements for the necessary frequencies. By so doing, a more workable coordination of the facilities of the two agencies can be secured and intercommunication, both wire and radio, can be developed as needed.

Similarly, a common purpose can frequently be accomplished through development of a coordinated communication system by the Forest Service and other Federal land management agencies such as the Park Service, Indian Service, and Grazing Service. The needs of the Forest Service should be carefully studied in working out such arrangements.

19. General

Communication planning should strive primarily to accomplish stability of facilities; quality commensurate with Service requirements; coordination with all other long-term plans, and economy in construction, operation, and maintenance.

These considerations are of such a broad nature as to require the contributions of many men during plan preparation. In order to accomplish this in an orderly manner, a policy has been established on "Regional Organization" and "Minimum Planning Requirements". Planning should keep pace with new developments in communication practices.

The following material on planning covers the minimum planning steps, together with more detailed recommendations on the mechanics of communication planning and plan records:

20. Field Study

Following the presentation of a proposal for construction or modification (see policy "Minimum Planning Requirements", item "C"), the first step in plan preparation in all cases is the assembling of a complete and accurate inventory of all communication facilities on or immediately adjacent to the area under consideration. When such an inventory is once established, it is to be maintained currently through the functions of the Regional Communications Officer, as set forth in the general policy statement on "Construction and Abandonment".

The field work and inventory should include the following:

(a) Inventory of the existing Forest Service lines and radio stations secured by actual field inspection to include:

(1) Map showing existing routing of lines, location of switchboards, tie-ins with commercial or other wire facilities, and location of permanent or semi-permanent radio stations.

(2) On the same map, or by overlay, show existing commercial and other agency telephone facilities on or immediately adjacent to the area.

(3) On same map, or by overlay, show existing power transmission lines and other agency or commercial radio facilities. Through contact with REA and commercial power companies, include power distribution extension proposals with anticipated date of construction.

(b) For each existing line, determine and record the following:

(1) Type of line.
(2) Termini.
(3) Purpose of original construction.
(4) Present use.
(5) Age, condition, and kind of wire, poles, hardware, switchboards, and instruments.
(6) Type of route (topography, ground cover, etc.).
(7) Condition of right-of-way.

(c) Assemble copies of all contracts and agreements relative to communications on the area or Forest. Note kind and location of ties with cooperator systems and free use not recorded in agreements.

(d) Secure best possible on-the-ground appraisal by Ranger and Supervisor of present inadequacies or faults and current and anticipated future needs.

21. Determination of Possible Future Boundary Changes

It is not expected that all District, Forest, Protection Area, and Regional boundary changes can be anticipated, but many of them can. In planning a line or a system, probable boundary changes should be studied carefully insofar as they may affect communications. The best available information on this matter should be secured from Supervisor and Rangers during the field study, and should be confirmed and expanded by the Regional Communications Committee.

22. Determination of Possible Future Headquarters

All communication planning should be tied to and coordinated with other Forest plans, both present and proposed, such as administrative, management, fire, recreation, and grazing. This is necessary because communications are to be considered as a service to, and an aid in the accomplishment of, all resource and protection plans. The proposed changing of or addition to a Ranger's headquarters, a fire tower, a recrea-

tional area, a timber sale, or similar projects, is to be considered in communication planning. Similar plans for adjoining Districts or Forests should be considered as they may relate to common use of communication facilities. All available information on this matter should be secured in the field study.

23. Determination of Possible Routes

All logical routes will be investigated and recorded for each line to be constructed.

As soon as field work has progressed to a point where a tentative decision can be made as to line routing, preliminary data should be secured on possible right-of-way requirements. The field study data should contain names of landowners, including federal, state, or county agencies, who may later be contacted for right-of-way agreements, and a brief statement of any conditions or local problems that may affect securing such rights-of-way.

24. Consideration of Planning Data

Following presentation of a proposal and accumulation of field data and plant inventory, the two should be combined into a physical plan through the following general steps:

(a) Select the kind of facility to be used through analysis of:

(1) Possible routes.
(2) Period of use (year-long or seasonal).
(3) Amount and importance of traffic.
(4) Presence of power-line interference.
(5) Ability to maintain physically and financially.
(6) Availability of existing commercial or other agency facilities.
(7) Necessity of contacting cooperators.
(8) Estimated construction and maintenance costs.

These will provide the answer as to the selection of ground return or metallic circuits; Forest Service wire or commercial wire (all or in part); wire or radio, and combinations of wire and radio.

Much of the basic information needed to arrive at the correct answer to this problem is available as factual data or can be estimated with a reasonable degree of accuracy.

(b) Alternate routes or locations must be considered. Data assembled from the field study will be correlated with technical data and proposed use (considering radio where applicable), possible future boundary changes, and shifting protection and administration needs. After this material has been thoroughly considered, the route should be selected which will give the most service consistent with minimum construction and maintenance costs.

(c) A determination must be made as to the maximum line loading that will result from the proposed mileage of wire; the number of telephone instructions, coils, and switchboards. The extent of the facilities (number and kind of circuits) must then be determined to prevent original overload and allow room for normal deterioration losses and possible expansion.

New lines should not be loaded beyond 75 per cent of their rated capacity and future additions to the circuit should not exceed the normal rating. (See Line Loading)

(d) Decision as to the class of facility to be used must be carefully analyzed. This point should be considered concurrently with the selection of the kind of facility, but is based primarily on anticipated period of use (permanent improvement, or limited period use, such as communication to a timber sale area where intensive future protection is not anticipated) and amount and importance of traffic.

Aside from the general considerations on anticipated period of use and ability to maintain, there is no inflexible rule or clear-cut method for establishing so-called "classes" of construction. The planner should keep in mind that a well engineered and properly installed system will provide more reliable communication with less maintenance and trouble-shooting than a poorly built system. Any original cost differential between the two will invariably be consumed in a short time by increased maintenance of the substandard system.

The guiding principle in selecting the facility should be to adjust the class of construction to needs and to the ability to properly construct

and maintain. It is far better to use a good ground return circuit where technical considerations permit rather than to attempt the use of a substandard metallic line. Strict differentiation should be recognized between "class" and "quality" of communication facilities. Regardless of class, the quality should be high.

(e) Additional considerations which must be weighed in plan preparation include:

(1) Esthetic values - location of lines along highways and through improved areas.
(2) Ice and snow loading on lines.
(3) Topography.
(4) Ground cover.
(5) Relationship to planned future developments.
(6) Rights-of-way.
(7) Coordination of Forest Service wire and radio facilities with other-agency facilities.
(8) Inter-District, inter-Forest, and Region-wide coordination of communication service.
(9) Regional coordination of radio frequency assignments.

25. Preparation of Plan

The mechanics of plan records can be set up in a variety of ways, but should contain at least the following elements:

(a) Maps as prepared from the "Field Study" data.

(b) Schematic or skeleton system diagrams for existing and proposed facilities, showing instrument and switching stations and mileage between each. This diagram is not related to geographic locations as are the map data. It is primarily useful in securing a rapid and accurate picture of the over-all plant, its internal inter-relations, undesirable looping and switching arrangements, and the relation to adjacent area communications through the switching facilities shown.

(c) Written material covering a general description of the proposed additions or alterations should be prepared. This material should be prefaced by the original written proposal and include:

(1) Name of termini or location of facility.
(2) Type of facility proposed and reasons for selection.

(3) Line mileage.
(4) Location and type of radio facilities.
(5) Right-of-way requirements.
(6) Statement of agreements necessary to secure pole contacts or service from commercial or other agencies.
(7) Statement of special problems, such as contact by Forest Service magneto systems with automatic exchanges.
(8) Estimated cost of construction and annual rentals, tolls, or other costs not covered by maintenance.
(9) Statement of maintenance problem (possibly on a comparative basis).
(10) Line capacity - present and that available for additional load of future expansion. (See line loading.)
(11) If the proposal anticipates that construction will be carried out over a period of time, a job priority should be established by the Communications Committee based on the urgency of field needs.

All of the foregoing field and office work, which has been carried out by the Regional Communications Officer, should now be in suitable form for presentation to the Forest Supervisor concerned and the Regional Committee for their consideration and approval.

The plan at this point should provide the basis for controlled expansion, deletion, rebuilding, or modification. The next step is the preparation of the working plan, which includes such items as detailed surveys and materials lists. The working plan should be started only after funds are scheduled, but be completed well in advance of the date of actual construction so that alterations may be avoided after the job is started.

26. Working Plans

Working plans should be prepared in sufficient detail to enable a qualified foreman to proceed with the planned construction and maintenance without further instructions and with only routine supervision. This type of planning is often referred to as "blueprinting". Such a plan is complete in its detail and should embrace all of the Regional practices and requirements in "project work planning".

The development of working plans should usually follow the Regional Forester's approval of the system or individual project. It would be good practice to be assured of construction funds, however, before proceeding with the planning and

obtaining necessary rights-of-way.

The recommended procedure in preparation of the working plan consists of making a preliminary survey of the route proposed on the plan map, and securing necessary rights-of-way. The field data are then used in preparing a plat or route map which will indicate structural details such as pole grading, numbering, guying, and transpositions. The final step involves staking out this final location of poles and guys and adjusting the alignment of the preliminary survey as necessary.

This work is immediately followed by the preparation of construction materials lists, final cost estimates, and the detailed written instructions to the Construction Foreman.

The locating of ground-return tree lines is, on the whole, a much simpler process than that required for metallic construction. The processes involved are primarily field operations and the entire subject of tree-line locating is, accordingly, covered in the "Tree-Line" section of this handbook.

27. Rights-of-way

Rights-of-way should be secured for the routes of all telephone lines not on National Forest land. In some states, rights-of-way may be secured on road rights-of-way through contact with county or state highway officials. In other states, private property rights extend to the center line of the road right-of-way. Where this condition exists, it is necessary that right-of-way be secured from the landowner and permission to construct along the road improvement secured from the proper county or state highway official. Any construction restrictions should be included in the permit.

Right-of-way agreements obtained from private owners should be complete in detail, leaving no verbal understandings over which future controversy may arise. In most cases, rights-of-way should be obtained as easements (see sample form). The legal recording of such instruments is not required, but is considered good business. Rights-of-way are necessary even if the crossarm only extends over the property.

Rights-of-way over public land administered by another agency will be handled as an agreement or by an exchange of letters between the proper administrative officials.

Railroad companies usually make stipulations, covered by their right-of-way form, for rights-of-way over railroad property.

Many of these stipulations are not acceptable to a government agency due to statutory restrictions imposed by congress. A smaple form, acceptable to the solicitor, is included in this handbook to cover the general railroad requirements. See Appendix, railroad right-of-way agreement. This form should be used. Where changes are necessary to meet railroad requirements, such changes should be reviewed by the Regional Attorney.

28. Preliminary Survey

The preliminary survey is an extremely important factor in determining the quality of the completed line and should be made or supervised by an experienced telephone line locator or engineer. Proper consideration to the use of long-span structures, controllable relations to power systems, vertical alignment, and location as related to factors affecting maintenance will, if properly applied, pay for the cost of such surveys many times over.

The survey crew should be made up of from three to five members, depending upon topography and ground cover.

The purpose of the survey is to determine horizontal alignment or traverse; vertical alignment to determine pole lengths and positions at grade breaks; location of guy anchors at angle points; any special structures necessary for long spans, power-line, water, or road crossings; location of power or existing communication circuits that may contribute interference to the line, and the usual ties to land subdivision and property boundaries and corners.

(a) A complete set of field notes should be taken by the engineer or locator. The field notes are to cover specifically:

(1) Soil type.
(2) Rock ledges and deep ravines.
(3) Rivers, creeks, lakes, ponds, swamps.
(4) Outstanding scenery.
(5) Railroad, highway, road, and water crossings.
(6) Electric power circuit crossings.
(7) Ornamental trees.
(8) Cultivated areas and orchards.
(9) Buildings.
(10) Oil and gas fields and mines.

(b) Office determinations based on these notes will include the following:

(1) Pole locations and number.
(2) Transposition scheme.
(3) Pole heights.
(4) Span length.
(5) Location and number of guys and anchor.
(6) Amount of clearing necessary by pole spans.
(7) Location of power lines within 1/2 mile of the route and of communication lines within 1/4 mile (show general type of power line and voltage).
(8) Ties to GLO or other surveys and land ownership and right-of-way locations.
(9) General problem of transportation of materials beyond existing roads or where unusual topographic conditions may require special tools or machines.
(10) Type of soil to be encountered in setting poles.
(11) Maps of the system.

29. Line Location, Pole

The following is intended to serve as a general guide in line and pole locating:

(a) Consideration should be given in route selection to:

(1) Direct or shortest route.
(2) Accessibility to transportation routes.
(3) Unusual construction requirements.
(4) Scenic and improvement values

(b) Locate poles in line. Tops of rake poles at angle points should be in line with unraked poles.

(c) Locate poles so that required clearance from other lines, railroads, highways, and roads is obtained.

(d) Locate "dead-end" poles so as to obtain good guying facilities. Where underground construction is necessary (used only when absolutely necessary), poles should be located to facilitate subsidiary construction and ease of pulling cable or wires through the conduit.

(e) When conditions make it necessary to install poles with crossarms, the crossarms should not extend over an adjoining property unless covered by a written agreement.

(f) When poles are set along roads or highways, they should be close to the edge of the road right-of-way and not placed in conspicuous places. (See policy, caption 15.) Poles should be set as far back as practicable from the shoulders of ditches or other banks. A check should be made with the proper officials as to any road improvement plans they contemplate for the road under consideration. This applies to road intersections as well.

(g) Avoid long curves - line should preferably consist of straight sections and corners. This will reduce the amount of guying appreciably.

(h) Avoid the use, where possible, of long or short poles for grading purposes by shifting the pole locations to avoid either top or bottom of depressions.

(i) Locate corner poles to facilitate good guying.

(j) Avoid the use of buck arms where possible to retain good construction quality without them.

(k) Use two-pole corner where pull exceeds 40 feet with #12 line wire or 30 feet with #10 or larger line wire.

(l) The stake designating the location of an anchor shall be placed at the point where the anchor rod enters the ground.

30. Survey Procedure

Details of the survey will vary with cover type and terrain, but the following procedure is generally applicable:

(a) Run traverse or random line taking pertinent notes as indicated and set reference stakes.

(b) Plot traverse and project proposed location.

(c) Locate proposed line on the ground, making adjustments of the projection as necessary.

(d) Chain the location, setting stakes at least every 150 feet along the route, except through

long spans. Also set stakes at:

(1) Grade break stations.

(2) Terminal poles for long spans.

(3) Poles which must be definitely located due to unusual topographic barriers.

(4) Crossing supports and at points of intersection (P.I.).

(5) Indicate on pole stakes, transposition points.

In flat and rolling country, the average span length to be used should be chained out and pole and guy stakes set in accordance with transposition section and standard requirements.

(e) Run Abney or hand levels wherever a difference in elevation of ten feet or more between poles could exist, assuming the poles may be located at any point within a normal span length, and record to permit plotting of a profile.

(f) Note size and extent of minor depressions or mounds and any barrier or obstruction that might interfere with setting of a pole directly on the location line and tie to station numbers.

(g) Take additional notes, as indicated in "Preliminary Survey", which may not have been possible at the time of running the random line.

31. Working up the Survey Notes

(a) Where control points only have been established, as in (d) under Survey Procedure, these points should be shown on the location which has been projected on the traverse sheet.

(b) The profile should be plotted and the control points established on the profile sheet. Conditions affecting pole setting, such as rock, steep side slopes, etc., should be indicated on the profile.

(c) The transposition engineer can now select the proper intermediate span lengths to arrive at a properly balanced transposition plan. The profile and its

appended data provide the necessary information for selection of pole locations as related to vertical alignment (grading) and pole setting.

(d) In the case of setting pole and guy stakes simultaneously with the survey of the final location, the stations and span of such poles should be set down on "location sheets". This information, together with the route map to indicate power exposures, can be used to make up the transposition plan.

(e) If pole stakes are set as the location survey is made, "location sheets" should be completed, showing all pole stations, pole numbers, pole lengths, and guying details.

(f) Any adjustments necessary in the field must be recorded and all related maps, profiles, or data sheets corrected to agree.

32. Transpositions

The purpose of transpositions in metallic line construction is to prevent cross-talk between adjacent circuits and to minimize noise which would otherwise be present as a result of induced voltages from power lines.

The transposition systems which have been adopted quite generally by commercial companies should be used on all Forest Service lines. Diagrams of the transposition systems, known as "R1", "R", "E", and "L" systems are included in the appendix. These diagrams are used as the basis for actual placement of wires on the crossarm or bracket. The use of the "R", "E", and "L" systems require a knowledge of the proper method of combining the various kinds of systems which depends upon length of the line, span length variables, and extent and position of power exposure. The "R1" system is used for exposed lines and is preferable for Forest Service Communication lines except where phantoms are to be used, in which case the proper "R", "E","L" system should be used. Accordingly, unless the communications Officer is qualified by training and experience to apply the standard transposition systems, the services of a qualified telephone engineer should be sought to prepare the transposition plan.

In order to prepare such a plan, the engineer must have all pertinent data on the proposed line, including number of circuits; all span lengths and pole numbers; location of adjacent power lines (if a power transmission line, the

power line transposition data may be required and should be secured from the operator of the line); location, type and length of any underground or cable construction; and, if the construction involves contact or poles with existing circuits, the transposition plan of such circuits must be known.

33. Transposition, Records for Construction

In order that the construction crew shall have a complete and correct record of the transposition plan, this information should be transferred to the "location sheets" by setting down the transposition type opposite the appropriate pole number. For information on the actual placement of the wires, the "R", "E", and "L" transposition diagrams in appendix of this handbook are used. These records are not necessary for the "R1" system.

Replacement of transpositions lost through destruction of a portion of the line can be accomplished by reference to the basic transposition diagrams as identified by the transposition type letter and number appearing on the pole or on adjacent poles.

34. Line Location, Tree

(See Construction Tree Line, Caption 43).

35. Material and Cost Estimates

Following completion of the survey and the preparation of the transposition plan and the guying data, a complete materials list should be prepared. Cost estimates should include the following:

(a) The survey and incident items.
(b) Materials - poles, wire, hardware, instruments, and accessories.
(c) Delivering of materials to the job.
(d) Rights-of-way (non-recurrent cost).
(e) Any other non-recurrent costs.

36. Labor Cost and Time Estimates

A job-time and labor-cost estimate should be made. There is little or no substitute for experience in preparing

such an estimate. The anticipated progress of the job will be affected by ability and training of the crew, the physical conditions encountered such as swamps, solid rock, desert or mountainous country, type of cover, and by the kind of facility being built.

37. Recurrent Costs Other Than Maintenance

A statement of known recurrent costs, such as pole and pin rentals and fixed charges for switching and other service, should be made up for presentation with the completed working plan and estimates.

38. Switchboard Diagrams

Diagrams of switchboards should not be on file, but should be attached to the inside of the board. Such diagrams should show, schematically, the wiring and include terminal identification so that all lines can be identified inside the board without the necessity of tracing.

39. Terminal and Distribution Diagrams

The terminals in all pole terminal cans and distribution terminal blocks should be clearly identified so that circuits can be recognized without tracing or "ringing out". Such information should be attached to the terminal block or inside the protective cover.

40. Letters of Instruction

Letter of instruction to the Construction Foreman should be prepared by the Regional or Forest Communications Officer for the signature of Forest Supervisor or Ranger. Letter of instruction for Maintenance Foreman should be prepared by the Supervisor or Ranger. Advice for the preparation of these instructions should be solicited from the Regional or Forest Communications Officer where technical problems exist.

The letter of instruction to the Construction Foreman should cover the following points and contain frequent references to the Telephone Handbook, giving caption, drawing and page numbers:

(a) Name and length of line to be constructed. If it

is a reconstruction job, what should be done with salvaged and unusable material in the old line.

(b) Require trip over the surveyed route to become familiar with the survey and check for adequacies of staking.

(c) Proper use of "location sheets" with which he is being furnished.

(d) The careful study of the Telephone Handbook. This should be covered even though the foreman is quite familiar with the handbook.

(e) Complete "right-of-way" instructions - how wide to brush, what to do with the brush, how it is to be done on patented or private land if right-of-way agreements contain applicable clauses.

(f) The checking of all material received with the bills of material, purchase orders, and specifications. Copies of all three of the above should be furnished the foreman.

(g) Full information on material supply, where it will be stored, how to requisition additional materials, and related information.

(h) What he is to do with material received when it is found not in accordance with the purchase order or specifications.

(i) Complete instructions on timekeeping and other fiscal requirements.

(j) Hours of work; transportation limits; commissary charges; rates of pay; names, titles, and addresses of all members of the crew. Any appointment limits should be stated.

(k) Complete safety instructions, amplified to the extent considered necessary for this job.

(l) Complete training instructions, amplified to the extent necessary for this job.

(m) Any allotment information considered necessary. Period of time to complete the job, and related information.

(n) A complete list of all tools and equipment to be used on the job and the supply point.

(o) Any specific installation or grounding instructions considered necessary.

(p) Any specific instructions necessary for trimming ornamental, fruit or nut trees. Also instructions covering special attention to brushing adjacent-to-travel routes, residences, hotels, or resorts.

(q) Any other general or specific instructions that appear necessary.

41. Data Folder

At conclusion of the general planning, work plan preparation and final survey, the following data should be on record:

(a) Written proposal and justification of project.

(b) All field study and inventory data.

(c) Record of action taken and modifications made by Regional Committee and Forest Supervisor.

(d) Base map indicating existing and proposed system together with overlays or other methods of showing relation to other communication facilities (wire and radio), power transmission lines, and adjacent Forest or District facilities.

(e) Schematic diagrams of the system.

(f) Survey notes, traverse and profile maps.

(g) Transposition plan.

(h) Completed "location sheets".

(i) Letter of instruction to Construction Foreman.

(j) Copies of all agreements and contracts.

(k) Cost and labor estimates.

At completion of construction, the following information should be added:

(l) Date of completion and cost.

(m) Transmission test data, loop resistance, and all ground resistances.

(n) Switchboard and distribution terminal diagrams.

(o) Location and description of any unusual structural devices, hardware, or instruments.

42. General

Telephone service on the average National Forest is largely dependent upon ground-return tree lines. These lines, extending through timber areas with but little cleared right-of-way, are constantly subjected to fallen objects such as trees or limbs. The mechanical flexibility which is built into tree lines enables them to render service under conditions that would prove a serious handicap to a line of rigid construction. However, the mechanical flexibility is often destroyed by objects accumulating on the line and acting similar to solid ties. Where this occurs, mechanical failures will result. Any accumulation of limbs, leaves, trees, or brush on or touching the line also lowers the signal and ringing strength and often renders the line useless until given adequate maintenance.

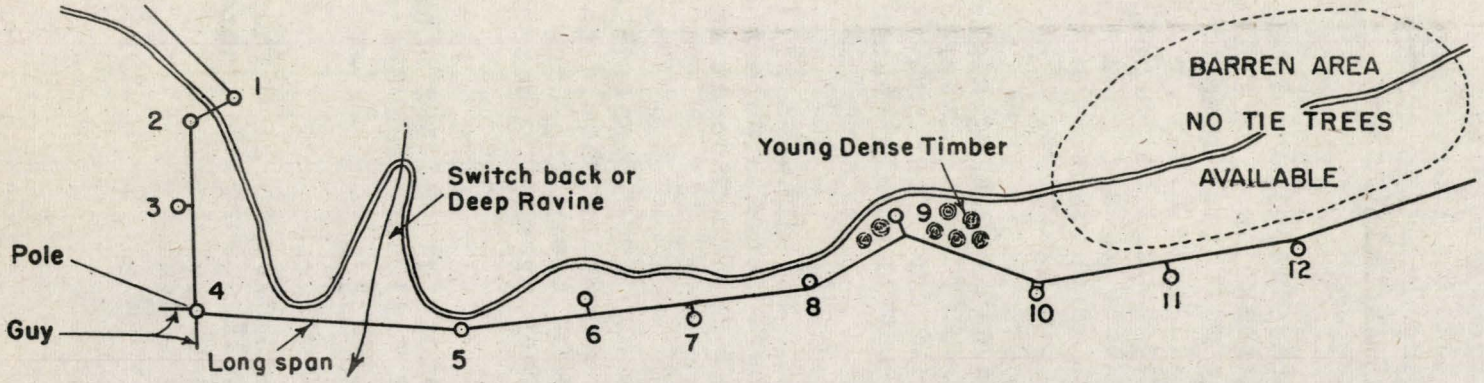
Construction of a metallic tree line is possible, but the slack wire feature often proves troublesome by permitting the two line wires to come in contact with each other. For this reason, metallic tree line construction is not considered practicable.

43. Locating Tree Lines

The location of tree lines should be delegated to one having had experience in such work. However, that is not always possible, but it is often possible to have an experienced tree-line maintenance man to accompany the locator. A typical layout plan is shown on page 31. By frequent reference to this plan and the other instructions which follow, an acceptable location job can be accomplished.

The locator should be alert to sheltering possibilities from high winds, falling timber, deep snow, floods, and landslides. Conditions on the ground should be studied and necessary reference to snow and flood records should be made. The full use of long-span type construction should be made where adequate clearance above ground is possible, and when no over-hanging timber or limbs occur.

It is often possible to substitute, where they can be securely anchored to rock ledges or boulders, iron rods or fabricated steel for wood poles. Locations for this type of fixture should be made to avoid, if practical,



TIE TREE	TYPE TIE USED SHOWN ON PAGE	REASON FOR SELECTION OF TYPE OF TIE
1 and 2	Page 38 (A)	Cross road at right angles. Light weight dead end
3	Page 37 (A)	No trees available set pole to equalize span
4	Page 36	Long span dead end pole. 2 way guys
5	Page 36	Tree dead end on long span
6-7 and 11	Page 37 (B)	Normal ties
8	Page 40	To avoid swinging wire over road put line wire on offside of tree. Tree pin necessary
9	Page 37 (B)	Long tie wire to avoid needless cutting of young trees
10	Page 38 (B)	Double tie to break sharp angle
12		Avoid setting poles by swing around barren areas

SUGGESTIONS FOR SELECTION OF TREE TIES FOR LINE ALONG A TRAIL OR ROAD

damage to it or the circuit wires from rolling boulders or landslides.

The line should be located adjacent to and in plain view of protection roads and trails. Short cuts which will totally obscure the line from view should be avoided except in areas of high esthetic values. Savings in construction costs when making location surveys should always be weighed against future maintenance costs.

Tree lines along or over roads or travelways must be located in such a way as to prevent the line from falling into the travelway should one or more ties break loose from the anchorage. This breakage is always a possibility and necessary precautions should be taken. This is usually done by selecting a tree to act as a shield and placing the wire on the side opposite the travelway. A shield tree can also be a tie tree.

Where possible, the locator should avoid crossing highways, roads, railroad tracks, and power lines. Underground crossings are costly to install and offer many difficulties in obtaining rights-of-way and maintenance of the line itself.

Where possible, all crossings of roads or highways will be made at right angles, however, where necessary because of physical conditions, the crossings may be made at an angle not to exceed 60 degrees.

Use of poles in tree lines should be avoided if possible except in long-span construction. Such spans should be free of overhead hazards. For straight tree-line construction, the locator should use trees even if a detour must be made to do so.

Location on steep slopes should provide for shorter spans and sharp angle between spans. This will have the effect of flattening the slope and also better holding of the sag in each span.

Full advantage should be made of rises over rolling country to locate tie trees on them. This will assure clearance without raising the insulators above normal height.

Two men should do the locating. They should be equipped

with a piece of light wire, 140 feet in length. This wire should be provided with a grip hold on each end. The head locator (boss) should be on the head end of the wire, and as he selects the tie trees (usually 140 feet apart) the line is pulled up tight. He then sights along it and selects the side of each tree along the line for the rear man to designate as the line wire side. This system is much better than pacing, as it gives positive assurance on the line location and span length. It also offers an opportunity to designating the clearing job more clearly by the rear man's breaking or cutting brush along the line as he moves forward. The proper side of the trees may be designated by use of strips of highly colored cloth or by other approved Regional methods.

44. Selection of Tie Trees

Suggestions for selection of tie trees will be found on page 31. Tie trees which throw a sharp turn in line should be avoided unless the diameter of the tree permits proper use of two insulators. See Diagram C, page 38. If practical, avoid large trees which are difficult to climb. Trees with a diameter of about 8 inches at line-wire heights are preferable.

45. Use of Poles in Tree Lines

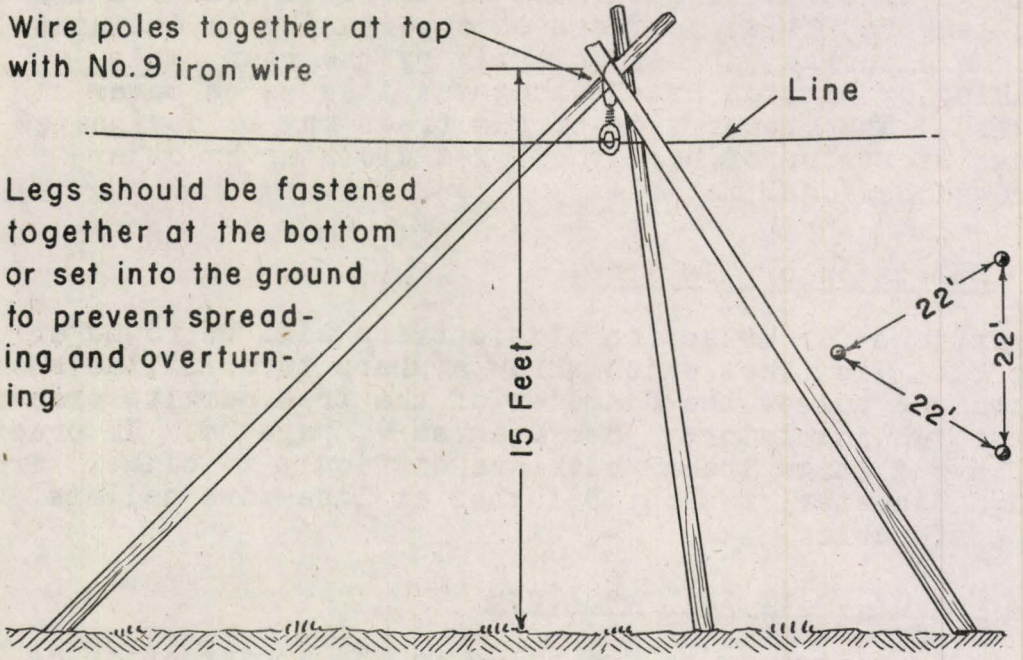
It may be necessary to use poles in the construction of tree lines. Where not over 10 consecutive poles with 160 foot spacing are needed, tree-line construction methods should be used, except that the insulator should be fastened to the pole by wrapping the tie wire around the pole 6 inches below the botton of the roofing. Staples should not be used for tying insulator to pole as in regular tree line construction.

When more than 10 consecutive poles are needed, the tree line should be dead-ended on the second pole from each end and the bracket type of pole-line construction used in between. For method of dead-ending tree lines, both regular and long-span, see pages 35-36.

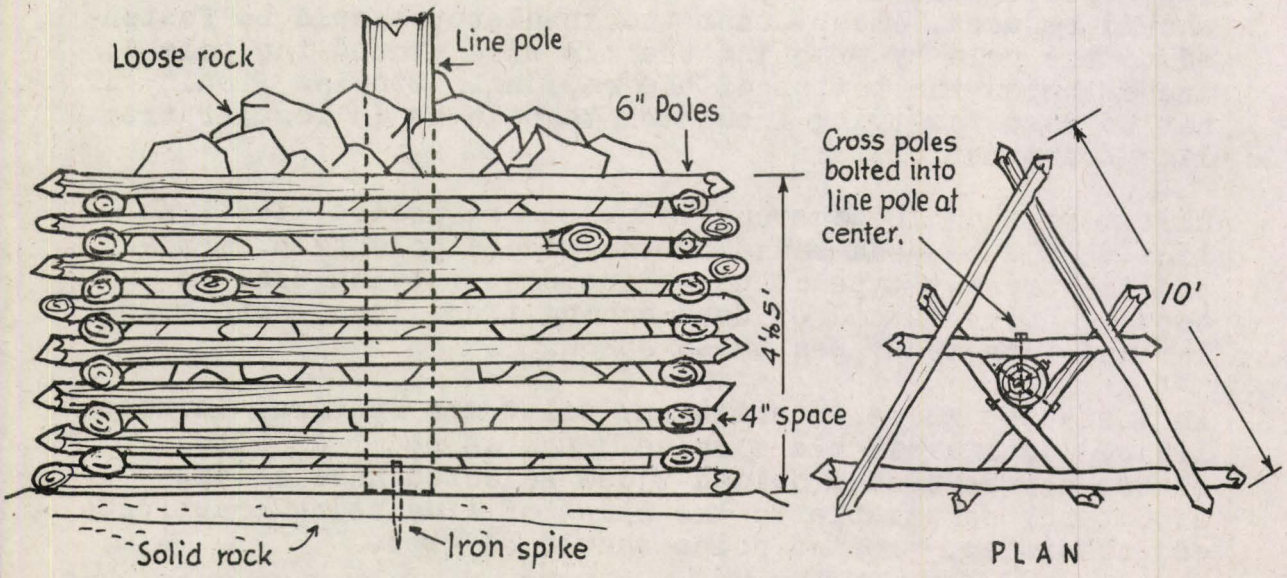
In instances where intermittent poles are required in tree lines, local available species, such as cedar or pitch stubs, may be used provided those selected have a life expectancy comparable to the class of line being constructed; otherwise, treated poles should be used.

46. Tripods and Cribs

In the construction of tree lines it is permissible to use an occasional tripod or crib in lieu of set poles where the use of poles would be impractical, as in the case of solid rock formations. The ground ends of the tripod should be supported with rocks where possible piled around each leg to offset wind pressure.


Wire poles together at top with No. 9 iron wire
Line
Legs should be fastened together at the bottom or set into the ground to prevent spreading and overturning
15 Feet
22'
22'
22'

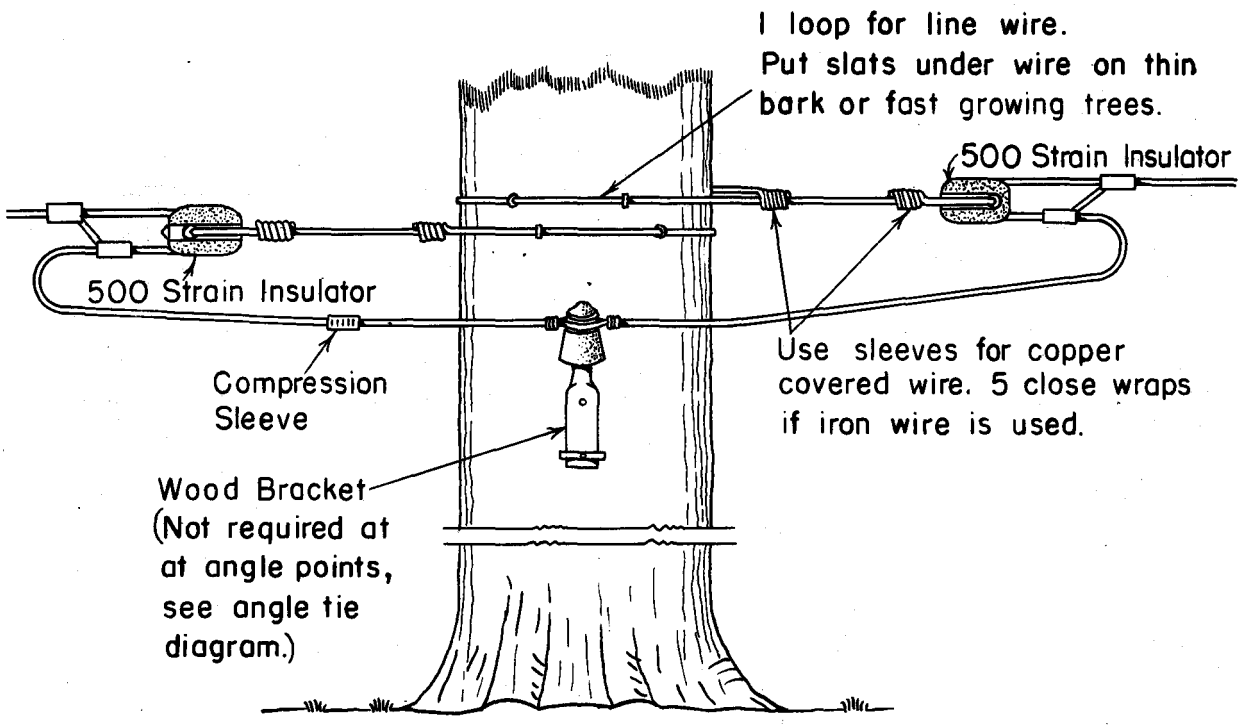
TRIPOD CONSTRUCTION



ROCK CRIB

47. Span Lengths, Normal Spans

Too much emphasis cannot be placed upon the need for near uniform span lengths in a tree telephone line, since this factor governs the uniform distribution of slack. Uniformity is the key to the success of this type of construction. The most satisfactory span length is 140 feet, with a variation from 130 to 150 feet. On steep slopes, the spans should not exceed 100 feet. Where tie trees are not available at regular span intervals, shorter spans should be selected. Where it is necessary, in order to avoid setting a pole or tripod, to put in a span up to 200 feet in length, an adjustment should be made by lengthening three or four spans on each side of the long span, gradually reducing the length in each span by approximately 15 feet until average span length is obtained. This will have the effect of maintaining the proper slack in each span. Where the span is 200 feet or more, it is better to set a pole or tripod with uniform spacing or dead end. If over and under clearance is obtainable, long-span construction should be used.


1 loop for line wire.
Put slats under wire on thin bark or fast growing trees.
500 Strain Insulator
500 Strain Insulator
Compression Sleeve
Use sleeves for copper covered wire. 5 close wraps if iron wire is used.
Wood Bracket (Not required at at angle points, see angle tie diagram.)

NORMAL SPAN TREE DEAD END

Dwg. No. I

48. Span Length, Long Spans

Spans of 1000 feet or more are both good practice and economical for tree-line construction under certain physical conditions and heavier construction is used. The following points are essential determining factors:

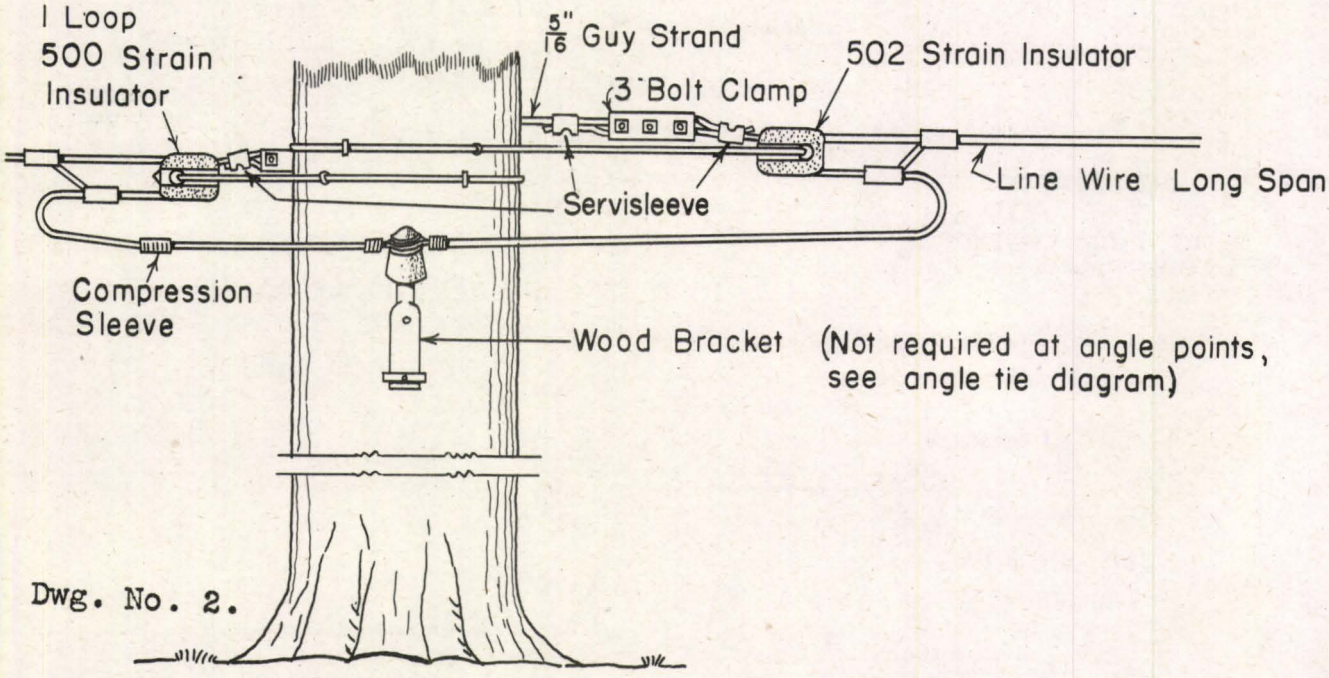
(a) Use only across canyons or swales where there is sufficient ground clearance to allow for proper sag. See sag tables.

(b) For supporting long-span use large trees, rock bluffs, or poles that are strong enough to carry the load that may be placed on the wires during sleet or ice storms.

(c) Be sure line is clear of any overhanging limbs or trees.

(d) Use gauge and kind of wire specified in long-span construction table page

(e) For these long-spans, the strength of supports, dead-ends, fittings and anchorage should be adequate to withstand the maximum tensions that may occur on the line.



LONG SPAN TREE DEAD END

49. Stringing Wire

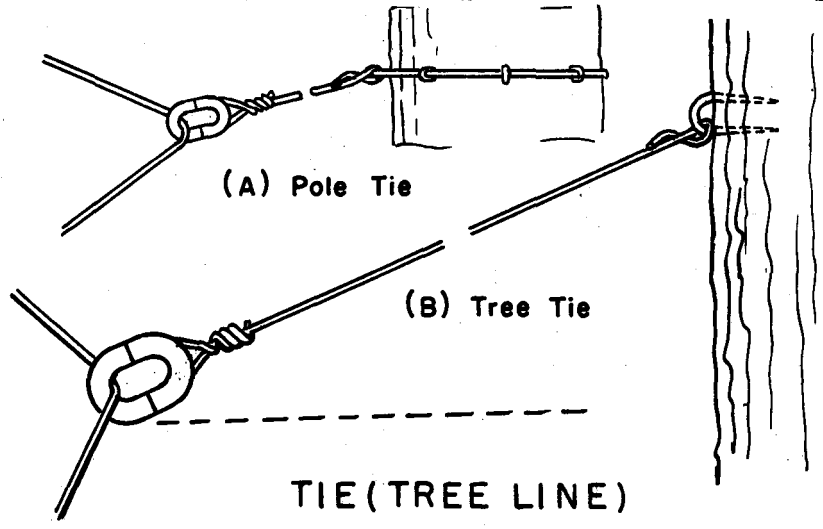
Care should be exercised in handling and paying out line wire. Do not drag it over rocks, barbed-wire fences or other sharp objects. The better practice, where terrain permits is for two men, carrying a "Barrow reel" to pay out the wire over the line locations. Wire can also be paid out from a modified type of this reel packed on the back of a horse.

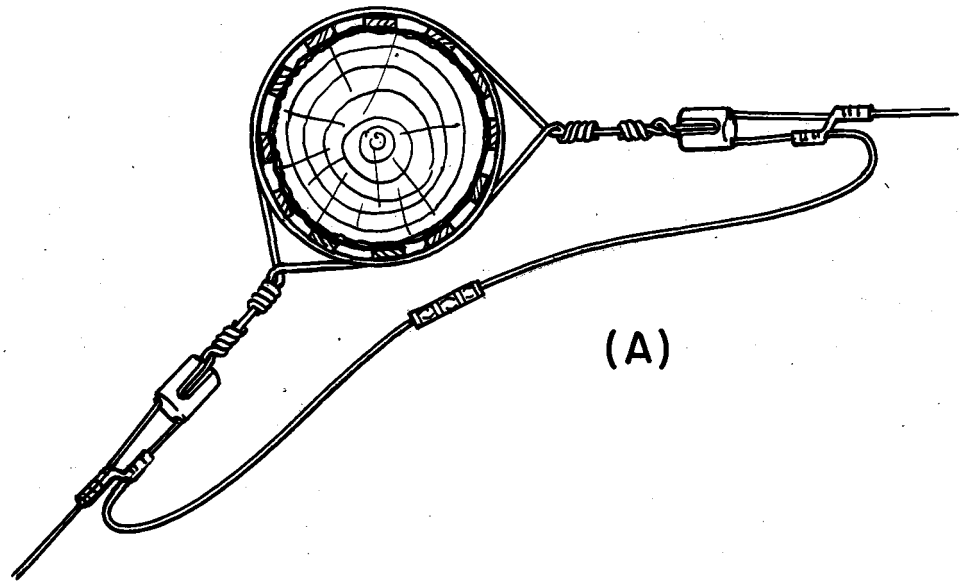
Wherever it is necessary to pull the wire over the ground,, every precaution should be exercised to prevent scraping, gouging or otherwise damaging the surface. The pulls should be short lengths, never more than can be conveniently handled by two men. Pulling wire by an animal or mechanical means should not be attempted.

50. Ties

Approved type of tree line tie consists of a solid tie around the split-tree insulator, with a #9 EBB iron wire or #10 copper-covered hard drawn steel wire. The tie wire will vary in length, depending upon alignment and other conditions. It should be attached to the tree staple with a twist as shown below. The tie should pull out of the staple when a pull of 200 pounds is applied.

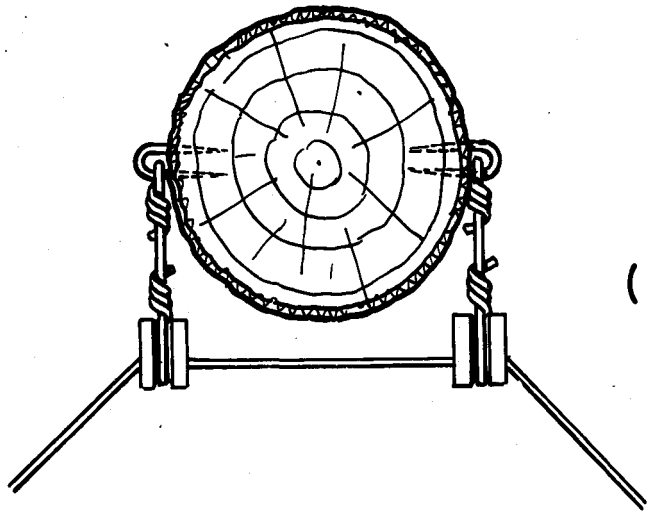
Ties should be made up on the ground and passed up to the lineman. They should be attached to the tree to give 12 to 15 feet clearance, except over roads and travelways where a minimum clearance of 18 feet is necessary. See clearance requirements page 118.





(A)

A Use where angle is too sharp for regular tie especially at road or other crossings. Use deadend method as an alternate.



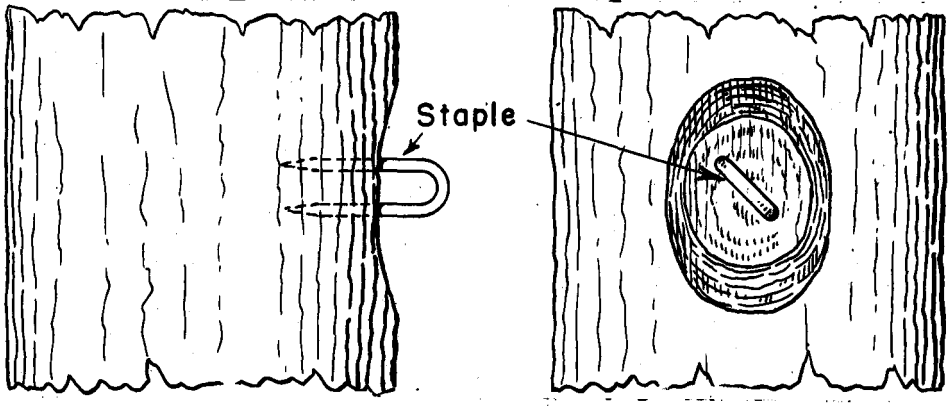
(B)

B Use where angle is too sharp for one normal tie. Preferable method over angle tie except at crossings.

51. Hanging Wire

Where practicable, a light but rugged ladder should be used rather than climbers. Men can work faster and better from ladders than with climbers, and less liable to injury. Ladders are better for the clearing crew while limbing trees. There should, however, be a pair of tree climbers on every project to take care of jobs which cannot be reached with ladders. These climbers should have 5-inch gaffs if working in thick-bark timber; 3-inch gaffs are preferable for thin-bark species such as hardwoods, lodgepole pine, and others.

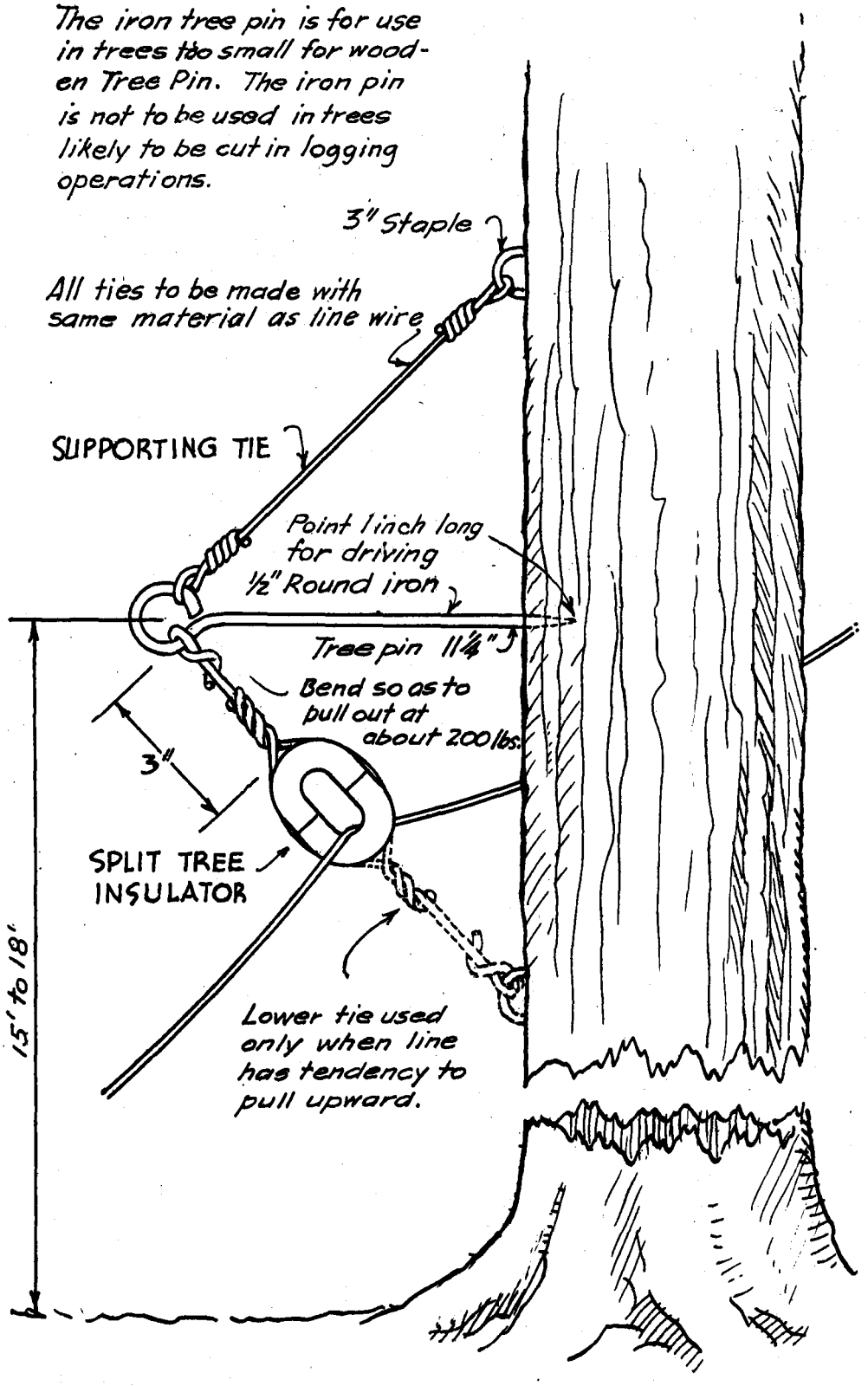
The bark on the tree, at the spot selected for the hanger, should be smoothed off before driving the staple. Do not cut through the bark in this process.



STAPLE INSTALLATION

Staples should be driven slightly off a vertical plane through the bark and into the wood. Do not drive the staple into the tree more than is necessary to obtain good support. Leave as much room as possible for tree growth around the staple. On thin-bark trees, use 3-inch staples and 4-inch staples on thick-bark species. Tree pins should be driven into the tree about 2-1/2 inches. The bark, at the point of a tree pin installation, should likewise be smoothed off without cutting into the wood.

A hand line should be used by the lineman for pulling wire and insulator to the staple. Wire should never be attached to the lineman's body, clothing, or equipment. Axes, large or small, and other line or clearing tools should not be thrown. Hand them or use a hand line where necessary. Sheaths should be used on all cutting edge tools when not in actual use.


The iron tree pin is for use in trees too small for wooden Tree Pin. The iron pin is not to be used in trees likely to be cut in logging operations.
3" Staple
All ties to be made with same material as line wire
SUPPORTING TIE
Point 1 inch long for driving
½" Round iron
Tree pin 11¼"
Bend so as to pull out at about 200 lbs.
3"
SPLIT TREE INSULATOR
15' to 18'
Lower tie used only when line has tendency to pull upward.

IRON TREE PIN

52. Splicing Line Wire

Ground return lines require the same high standard of construction to give satisfactory and reliable service as does a metallic line. Compression-type sleeves should be used exclusively for line wire splicing in all permanent lines construction and maintenance work. For specific instructions see splicing, connection and tapping line wires.

53. Sag or Slack

Slack is necessary to a tree line. Without the proper amount of slack, distributed equally in the spans, a tree line takes on the form of more rigid construction. Where this condition exists failures are inevitable. Slack is considered proper when it is possible to pull the wire to the ground between the hangers of standard height with an applied weight of from 75 to 90 pounds. For span lengths of from 100 to 140 feet, the proper amount of slack should be between 3 and 4 feet. In order to maintain even distribution of slack, all spans must approximate equal length, except when deadended. Remember, it is better to have too much slack than not enough. However, always maintain the standard ground clearance.

Never use block and tackle for pulling up wires in normal span construction. Surplus slack, if any, should be removed after the wire has been hung and final clearing is completed. For long-span, deadend construction, use sag tables given in pole-line methods.

54. Downhill Grade Snubbing

The stiffness and smoothness of copper-covered hard drawn steel wire presents a difficult problem where tree lines traverse grades exceeding 20%. Breaks in the line along such slopes usually result in the line wire sliding to the bottom of the slope and piling up in a tangle that is not practicable to salvage.

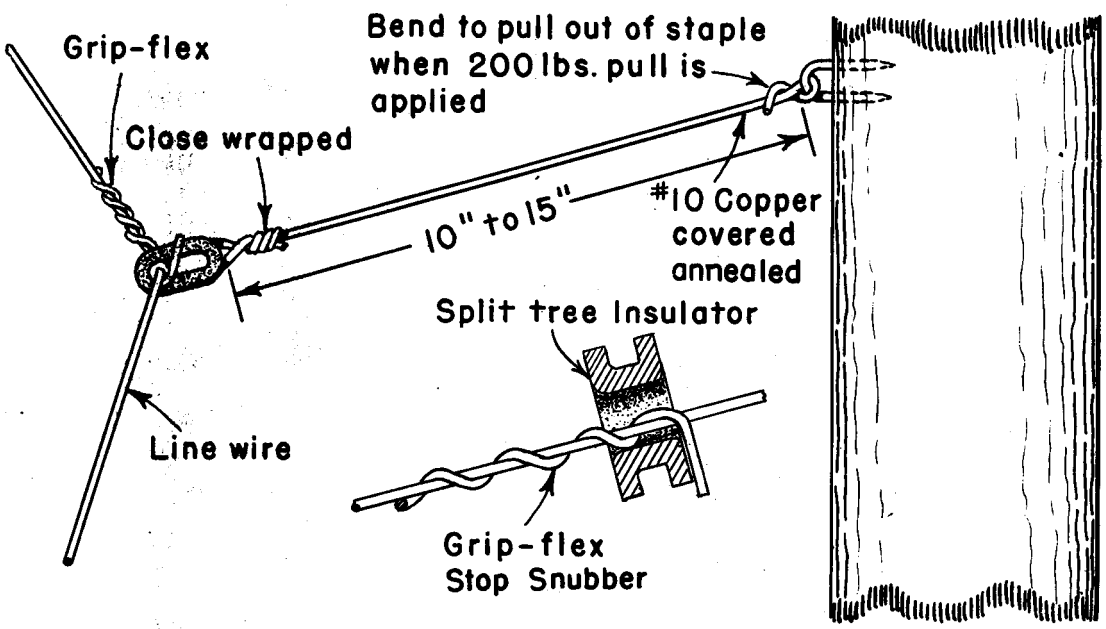
Snubbers attached to the line wire on the uphill side of each insulator on steep slopes will reduce this slippage. A standard Gripflex snubber which has a 2" section bent to form a projection at right angles to the line wire has been developed to meet this purpose and should be used where copper-covered steel wire is used for tree line construction.

In applying this snubbing tie, the snubber wire is wrapped on the line wire at the point where it passes through the insulator. The uphill end of this reinforcing wire is bent at right angles to the line wire and rests against the insulator. The stiffness of this right angle bend is sufficient to hold the slack in the line wire and to prevent this slack from creeping down hill due to swaying of the wire. However, if a tree should fall across the line wire, the pull is sufficient to allow the hook on the snubbing tie to slide through the insulator, thus minimizing the possibility of breakage of the conductor.

Maintenance men should be on the lookout for any Grip-Flex snubbing ties which have pulled through the insulator, and if any are found, they should be replaced in their original position. The Grip-Flex snubbing tie serves a useful purpose in definitely locating the point on the wire which should be against the insulator to maintain the original constructed distribution of slack.

Galvanized iron wire has a rough surface and does not have the spring tendency that copper-covered steel wire has; therefore, it is less subject to creeping or slipping.

GRIP-FLEX STOP FOR STEEP SLOPES



55. Clearing

Clearing for tree-line ground return construction should result in a minimum clearance of 4 feet between wire and brush or limbs. It should be accomplished during the season in which the least amount of sprouting will occur. The line location should be brushed lightly beofre the wire is reeled out and again after the wire has been hung on the tie tree and the slack pulled up. Often this procedure will require cutting out excess slack, but it will eliminate unnecessary clearing. Clearing should be sufficient to last for a year at least. Every foreign object touching the line wire adds to the load on the line. Frequent removal of any accumulation of limbs, twigs, and fallen stems should be made.

Clear-cutting or daylighting of such rights-of-way should be avoided through timber stands due to accelerated growth of brush which often results from such clearing.

Clearance between wire and solid body sound trees need be only sufficient to prevent swinging contact with such trees.

If the line in question is to provide winter service, the clearing and pruning must be carried out with due consideration to removal of small trees and branches that might possibly be weighted down onto the line by snow or ice.

Trimming is necessary only on the line side of the tie trees and on obstructing intermediate trees. All tie trees should be neatly and evenly trimmed.

The limbing of standing trees will be greatly facilitated by the use of one of several different tree-trimming tools which are available from manufacturers and supply houses or may be made up specially. For some types of young growth, a tree trimmer operated by a lever or rope on a pole will expedite clearing. For larger limbs, a man on the ground using a trimming saw with extension handle can do faster and better work than by climbing the tree.
All snags, particularly rotten ones, and leaning trees which appear dangerous and may later fall on the line wire, should be felled at time line is constructed.

56. Brush Disposal

Not a great deal of brush results from tree-line construction. However, if local policies require piling and burning, be sure the piles are not under the line wire. If

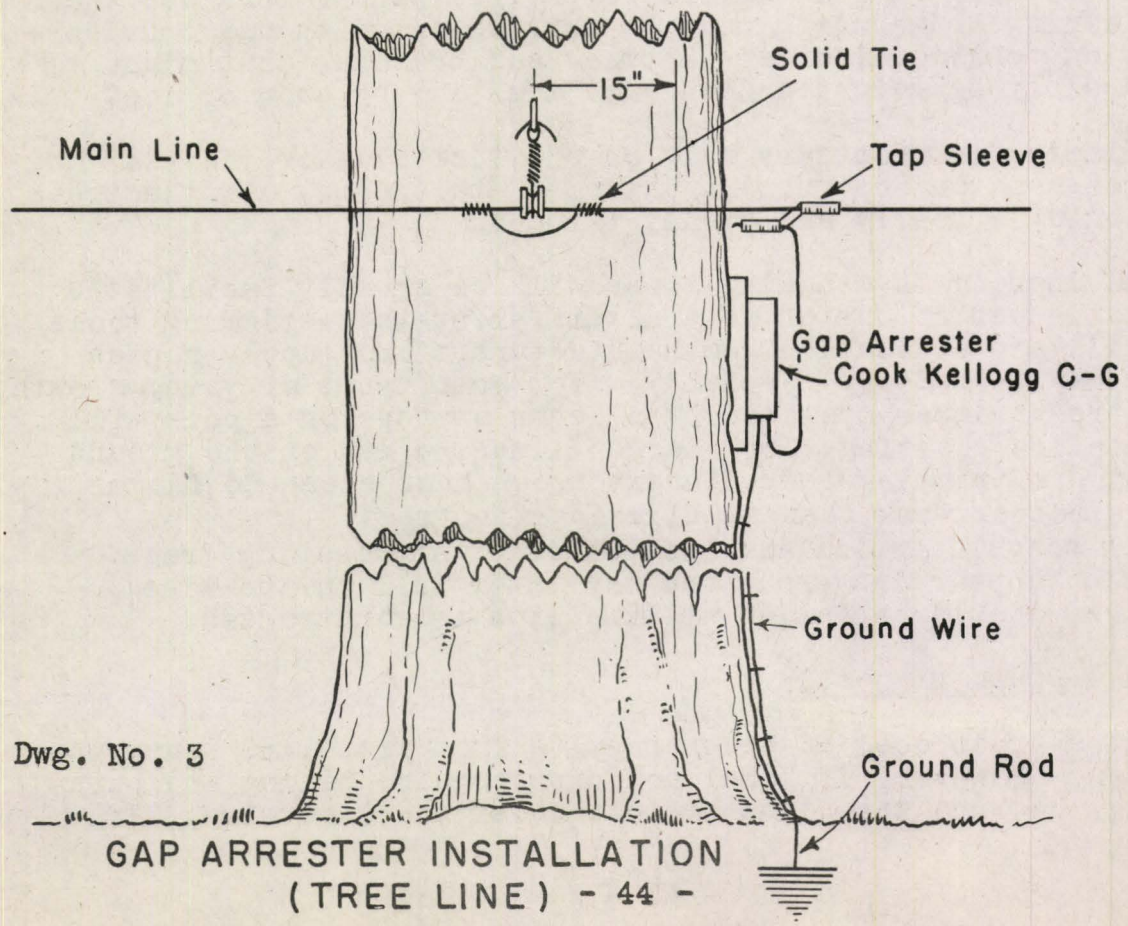
not disposed of by burning, the brush should be pulled back off the right-of-way to facilitate travel and maintenance.

57. Size of Crew

Three to five men, including foreman, usually make the best sized crew for tree-line construction. More men can seldom be used advantageously unless exceptionally heavy clearing is involved. Usually three men can take care of the wire stringing and the clearing while one man hangs the wire. The foreman usually makes up the tie fasteners.

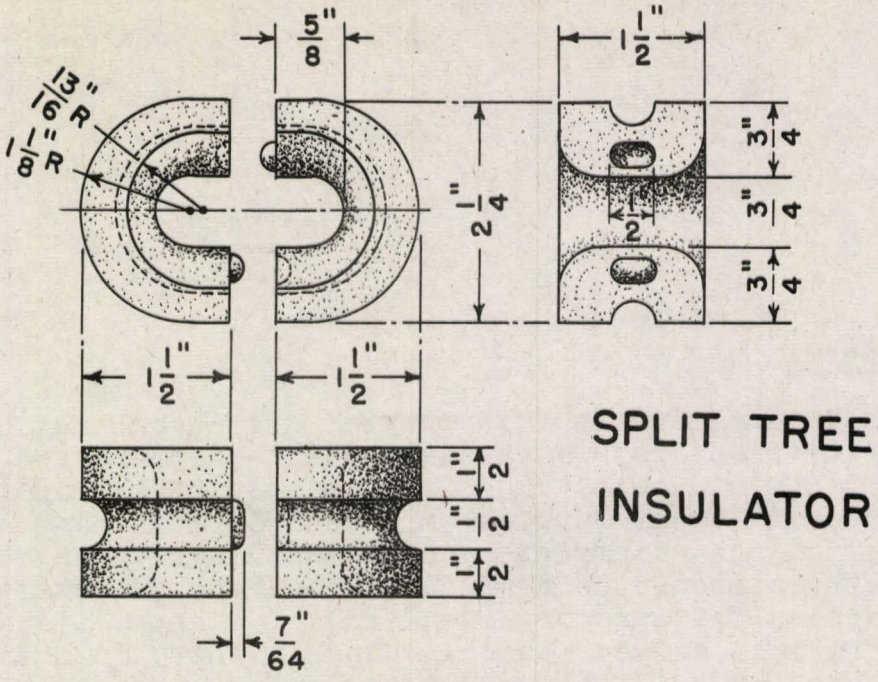
58. Lightning Protection

Tree lines, because of their locations, usually running to towers on the higher peaks and along ridge tops are exposed to severe lightning storms. Lines running up to the high peaks function similiar to lightning rods in attracting lightning and unless discharge features are built into the line considerable damage may result. The frequent installation of ball-gap arresters along the line with adequate ground connections will not only prevent lightning damage but will save considerable trouble shooting and permit the line to function properly.



Dwg. No. 3

GAP ARRESTER INSTALLATION
(TREE LINE)



SPLIT TREE INSULATOR

59. Tools Required for Tree-Line Construction

1	reel, hand barrow
2	ladders, light, 16-foot. Extension ladders not recommended.
2	axes, double bit
1	saw, cross-cut, adequate length
2	Climbers, tree, pairs
2	belts, tool
2	straps, safety, rope with steel core preferred
3	pliers, pairs, 8-inch, side-cutting
1	tool, splicing
1	axe, hand
1	saw, pruner's
1	saw, pruning, long handle
2	ropes, 25-foot, 3/8 inch, for hand lines

60. Materials Required for Average Mile Tree Line

1-1/10	wire mile line to each measured mile. (This is necessary to compensate for angles and long ties).
3	sleeves, splicing compression-type
1	sleeve,dead-end
38	staples, 3- and 4-inch, as required
4	pins, tree, iron
4	insulators, strain, #502 - #500
38	insulators, split-tree
4	connectors, bridging, iron to copper
3	snubbers, grade (for steep slopes)
38	grip-flex reinforcing ties

CONSTRUCTION
(POLE LINES)

61. General

The methods outlined in this chapter are a combination of those developed by commercial telephone companies through tests and research and those resulting from the experience of Forest Service employees in telephone construction and maintenance on the National Forests. These methods should be recognized as those necessary to accomplish satisfactory standards of construction in an efficient and economical manner. There is nothing in this chapter to discourage progressive suggestions.

Field experimenting to find the methods is costly. Where a need for experimental work is apparent such need should be reported through regular channels to the Regional Forester and by him to the chief where consideration will be given to the need and to the assignment of qualified personnel to conduct the experiment or research work if this appears desirable or necessary.

Drawings and tables are used and referred to freely in this chapter. They are designed to illustrate methods of accomplishing satisfactory standards.

Many safety suggestions are included. They should be studied memorized and followed until rendered absolete by the adoption of better safety measures.

62. Planning the Construction Job

Before starting the construction job, the Construction Foreman should thoroughly familiarize himself with the location sheets and the survey route of the line to be constructed. This can best be accomplished by traveling over the entire survey route, having copies of the location sheets at hand. Each planned, out-of-the-ordinary structure and physical feature should be studied at its location. The foreman should make such additional notes as he considers necessary at that time. Changes will not be made in the detailed plans at any time without the approval of the proper authority.

Following this familiarizing operation, the Construction Foreman will then plan his organization and equipment needs and the distribution of materials and supplies along the route of the line. Before starting the work, he will check on rights-of-way and be sure that all those required have been obtained.

63. Clearing

The uninterrupted operation of a metallic pole line circuit is largely dependent upon the degree and thoroughness of right-of-way clearing. Except where timber values or esthetic considerations prevent thorough clearing, the right-of-way should be cleared of line hazards to the greatest extent commensurate with reasonable cost.

It should be borne in mind that line damage resulting from inadequate clearing must be repaired, and that the eventual cost will exceed the initial investment in a good right-of-way clearing job. The attendant loss of service must also be considered.

For the reasons given above, it is desirable to drop all snags which may eventually fall across the line at the time of construction.

Solid bodied trees having a diameter of 8 inches or more at wire height may be left standing if not less than 30 inches from the nearest wire. In an area of sound trees this indicates a clearing varying in width from 6 feet for bracket line to 15 feet for ten-pin crossarm construction.

The effects of complete daylighting upon growth in thick stands should be considered as for tree-line clearing.

All limbs and branches above the wire and within a vertical distance of six feet or those that may become snow laden and bend toward the line within this distance should be removed.

Within the limitations imposed by esthetic considerations in scenic areas, all fast growing trees and brush beneath the line wires should be removed. Clearing of brush and small trees under 8" in diameter should extend approximately

six feet to the side of the outside line wires. If brush is of a slow growing type and will not reach line wire height, only a foot trail between poles and a 10 to 20 foot radius fire protection clearing around the pole need be made.

The clearing requirements should be set forth in the detailed plan. The clearing itself should be accomplished in a workmanlike manner, with due consideration to the appearance of the clearing work. Ragged, uneven trimming, poor axemanship, bark-stripping, and the like, should be avoided. The right-of-way clearing crew should be alert to possible hazards from old snags or decaying green trees. Felling should be done by a trained crew working a safe distance from the remainder of clearing crew. The use of a pruning saw for limbing is preferable to an axe, bush hook, or hatchet. If possible, right-of-way clearing should be done during the non-sprouting season. Care should be exercised not to disturb any of the route survey stakes, fences, other wire facilities, corner posts, or corner trees except to trim when necessary. The clearing crew should be provided with the proper tools and sharpening equipment. Dull tools are accident breeders, as are loose or improperly handled tools.

64. Brush Disposal

It is most desirable to handle the brush disposal job concurrently with the clearing. However, all brush should be disposed of in accordance with Regional policy. If the brush is to be burned after the poles have been set and the wire strung, the piles should be small and to one side of the clearing. Small brush piles will prevent damage to adjoining trees and brush and will also assure protection to the wire from the heat.

65. Span Lengths, Pole Lines

By increasing the span length the number of poles can be materially reduced. Since the poles, their setting, and replacement constitute the major items of construction cost, it will be standard to utilize the longest span length consistent with loading and topographic conditions.

Span length for various loading conditions are given below:

Span length	No. of poles per mi.	Use
50' - 132'	40 - 105	In exceptionally heavy loading areas
150' - 212'	35 - 25	Heavy loading areas
175' - 251'	30 - 21	Medium loading, average terrain
250' - 500'	21 - 10.5	Light loading, flat or rolling country

66. Extra Long Spans (metallic circuits)

As in the case of tree line construction the use of long spans across canyons is a desirable construction practice. Spans up to 1000 or 1200 feet are practical in many instances where loading and topography will permit.

67. Short Spans in Extreme Loading Areas

Telephone lines to some lookout points, and across mountain passes or ridges where severe ice and snow loading is a factor should be constructed with short spans to carry the heavy load that may be placed on them.

68. Holes, Poles

The stability of the pole line is dependent upon the depth of setting to a large degree. Shallow setting will result in maintenance problems that are costly and the dependability of the line will be reduced.

Holes will be dug at those spots selected by the locator. Where rock is encountered, it is permissible to move (except transposition and corner poles) up to ten feet in either direction on the line of the survey. The holes must be large enough to permit setting of poles without cutting or tapering the pole butt. Holes should be dug perpendicularly. Construction foreman should make sure that all holes are of the right depth for the class of pole and the soil condition.

Standard Pole Depth Table

Length of pole	Pole Depth (unguyed) *Depth of setting in feet		
	Firm Soil	Sand or Loose Soil	Rock
20	4	5	3
25	5	5½	3
30	5½	6	3½
35	6	6½	4
40	6	7	4
45	6½	7½	4½

*Unguyed corner poles should be set 6 inches deeper than shown in the table. In very swampy or wet soils additional depth of setting will not necessarily give the desired stability. In such cases swamp footings and under ground braces should be used. For long spans 600 feet or over an additional depth of 12" should be provided.

Hole depths are measured from the lower side of the ground slope. After the hole has been dug, the survey stake should be reset close to the hole for reference of the pole-setting crew.

Due to topographic conditions, the holes will usually have to be dug by hand, although, in a few instances, it may be advantageous and economical to use a machine borer.

In clay or adobe soils which are extremely difficult to dig with bars and shovels, the blasting method of excavation is often most effective. In general, best results are obtained by blowing a shallow hole (1/2 to 3/4 of the depth of the pole hole) first. After the

earth is removed another bore hole should be drilled to the desired final depth, loaded and fired. From a safety standpoint the use of completely separated blasting operations is preferred over multiple charges detonated simultaneously. Because of the variety of soil conditions which will be encountered it is not practicable to specify quantities of dynamite to be used but work should always be under the direct supervision of an experienced and certified powderman. A blasting mat should always be used to cover a blast located under a telephone, telegraph and power lines, near buildings, railroads or other structures. If the surrounding vegetation is dry the hole should be covered as a fire prevention measure.

After the hole has been completed it should always be covered to avoid danger to persons and livestock. If the pole itself is unavailable for such purpose, boards or small poles may be used.

69. Anchor Holes

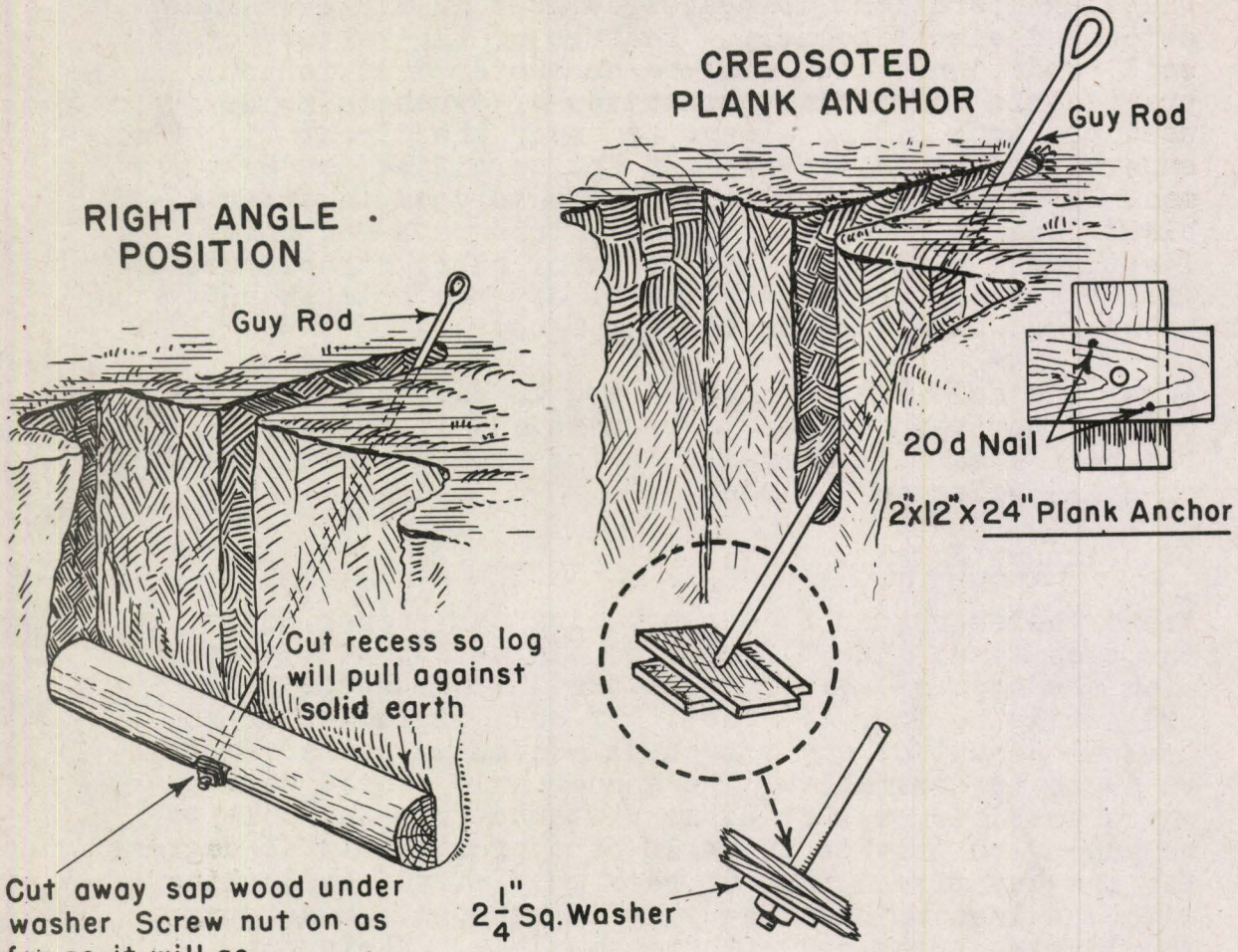
Anchor holes should be dug by using the proper tools for each type. The diameter or dimensions will vary with the type of anchor to be used. The depths will ordinarily be four (4) feet. If soil is loose, or an unusual amount of guy strain is evident, another foot of depth is desirable. The anchor hole should be dug, where possible, a sufficient distance from the pole to be guyed, to provide an angle of approximately 45 degrees for the guy wire. Head or back guys should be in line with the lead which the guy is to support. Side guys should bisect the angle where possible. Where not possible to bisect the angle, a head or back and side guys should be used.

70. Anchors - Log and Plank

Rot-resisting wood should be used where possible. Steel and iron plates, grader blades may be substituted for wood. Sections of old, treated telephone poles make desirable anchors. To install, dig hole large enough to fit the anchor; recess the bottom on the pull side so log will pull against solid earth; bar out a slot for the anchor rod. The rod should extend 6 to 12 inches above ground. Assemble the anchor and place it in the prepared recess. Earth should be well tamped as refilled.

Log anchors should be not less than 6 inches in diameter and approximately 4 feet in length.

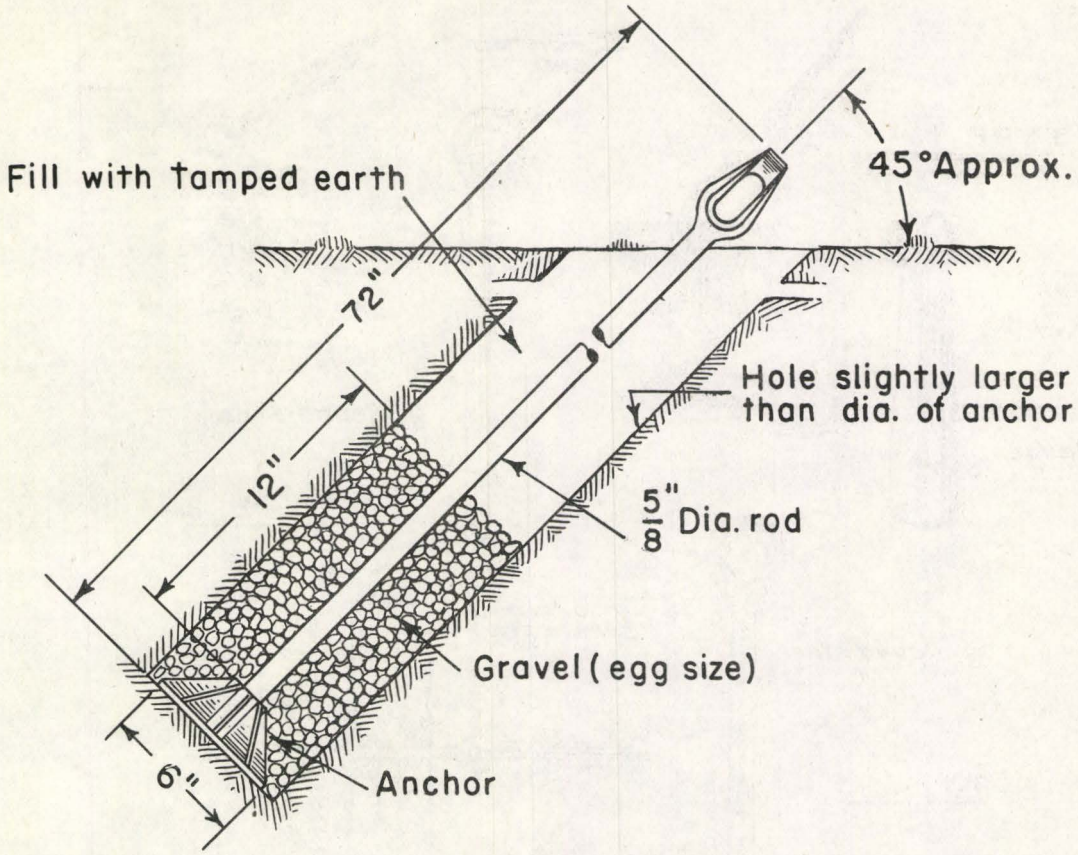
Plank anchors should be 2" x 12" x 24", preferably treated.


CREOSOTED
PLANK ANCHOR
Guy Rod
RIGHT ANGLE
POSITION
Guy Rod
20 d Nail
2"x12"x24" Plank Anchor
Cut recess so log will pull against solid earth
Cut away sap wood under washer Screw nut on as far as it will go.
2 1/4" Sq. Washer

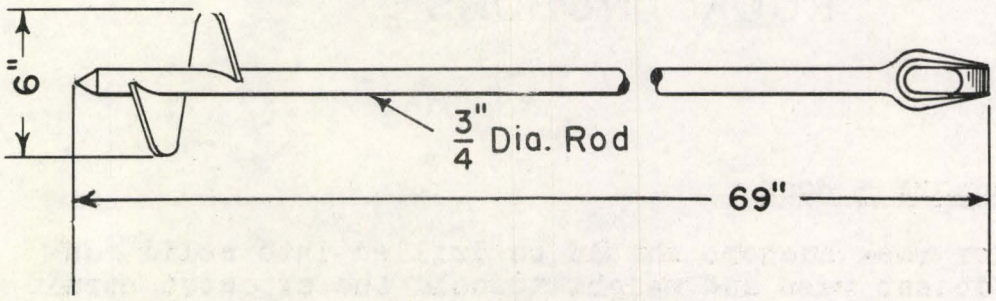
LOG AND PLANK ANCHOR

71. Anchors - Cone or Steelwing

For installing cone anchor, bore a hole slightly larger than the diameter of the cone and at the desired angle. Steelwig anchors should be installed by first driving a crowbar about 18 inches into the earth at the desired angle and working the bar in a circular motion until the top of the hole is about 7 inches in diameter. Place anchor in hole and use crowbar to screw it into ground to the desired depth.

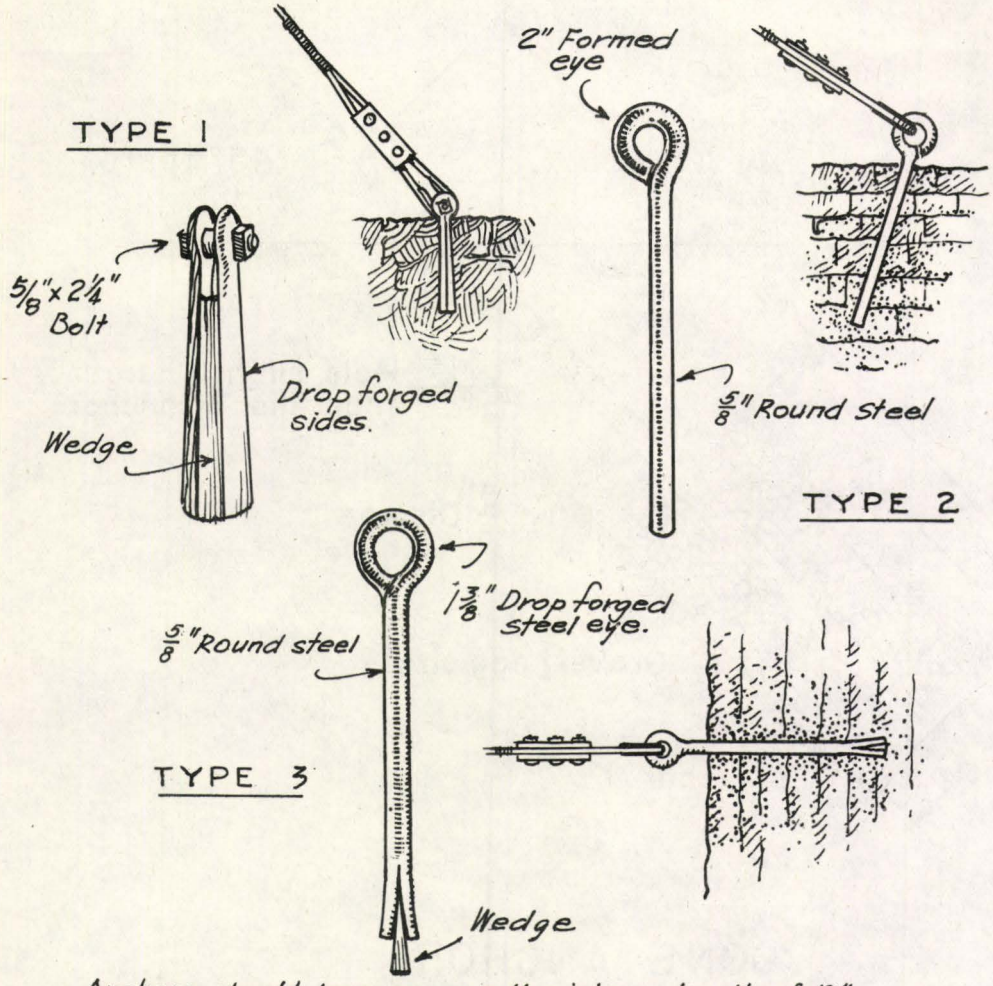


CONE ANCHOR



STEELWING ANCHOR

HOT GALVANIZED



Anchors should have an overall minimum length of 18"

ROCK ANCHORS

72. **Anchors - Rock**

Holes for rock anchors should be drilled into solid rock of sufficient mass and weight to hold the expected strain with a good safety factor.

Anchors should be imbedded in rock with thin mixture of sand and cement (grout). The strain should not be applied until the cement has had time to set thoroughly. Anchors should have a minimum length of 18 inches.

POLES

73. Handling and Delivery of Poles

Care must be exercised when handling poles treated with creosote preparations, to protect workmen from creosote burns. Such poles should not be handled by hand any more than necessary. Observe the following general rules:

(a) Handle with carrying hooks and peaveys whenever possible.

(b) Wear gloves and keep shirt sleeves down. Keep neck covered with collar or handkerchief.

(c) Keep pants legs or overalls well down over the ankles or boot tops.

(d) Never rub the eyes or wipe off prespiration with the hands or with articles of clothing which have come in contact with the creosote.

(e) Handle butt treated poles with care. Use hooks only on untreated portion.

74. *Creosote Burns

To prevent creosote burns, plain vaseline, applied generously to the face, hands, and other exposed parts of the body has proved the most effective. Occasionally, however, fair-skinned workers sustain mild forms of burns despite a heavy application of vaseline. Papier mache surgical face-masks afford excellent protection. Also, dark sun-glasses have proved quite effective in protecting the eyes.

The most important step in treating creosote burns is to thoroughly wash the burn(s) with soap and hot water in order to remove the fine particles adhering to the skin. This is to be followed by specific medication. Best results have been obtained from the use of Foille solution (containing various calcium salts, benzocain, sulphur, and vegetable oil base) which is available at any wholesale drug house. Application of this solution usually gives relief from burning within five to ten minutes.

In all cases of even the slightest burning senation in the eyes, a three percent boric acid solution should be used as an eye-wash, followed by a boric acid ointment application.

If possible, the treating and handling of creosoted material should be done by colored or dark-skinned workers.

Where the preventive measures and the first-aid treatment outlined above give no relief, the patient should be furnished with professional medical aid.

*The above was extracted from Adolph D. Jones' "Journal of Industrial Hygiene and Toxicology, 1943", page 418.

75. Trucking Poles

A truck equipped with semi-trailer is usually the best equipment to move poles from a concentration yard, treating plant or railroad car. The truck should have a minimum capacity of 1-1/2 tons; the trailer should be equipped with dual wheels and a goose-neck coupling having a reach of 20 feet. Larger trucks may be used to advantage where a large number of poles is to be moved and where difficulties will not be experienced at sharp curves, down grades, or weak bridges. Loads having a wide variation in pole length should not be hauled at the same time, except partial loads.

76. Loading Poles on Truck-Trailer Combine

Poles should always be unloaded from railroad cars in accordance with instructions given under captions 76 - 78 - 79 - 80. Unloading directly onto a truck from a flat car or above the sides of a gondola car is dangerous and should not be attempted. This requires that poles be loaded on a truck-trailer either from the ground, a ramp, or a skidway, except those poles below the sides of a gondola car, which may be loaded directly from the car to the truck.

The hand method of loading light poles (up to 25-foot, class 6 pole) on a truck is the most efficient. Larger poles should be skidded onto the truck-trailer by the use of a rope loop with both ends of the rope securely fastened. Care should be exercised that the skids are securely placed; one over the back wheels of the truck and the other over the trailer wheels. The heavy or butt end of the poles should be toward the truck.

Each pole should be rolled up the skids keeping both ends parallel during the process.

Poles loaded on a truck-trailer should be securely bound near each bolster with chains and binders before moving

the truck. Danger signals adequate to comply with state or city regulations should be attached to each load. Hand signals should always be used well in advance of any abrupt change in speed or direction.

77. Unloading Poles from Truck-Trailer

When unloading poles from trucks at storage yards, the following procedure should be followed: Spot the truck-trailer at the proper location; place skids in the same position as in loading; release the binding chains, and with peavey or canthook roll off the poles from the butt end. Never allow a man to climb on top of the pole load.

When distributing poles along the route of the telephone line, where roadway is available, the binding chains should be released at the first pole site. With the man standing on the ground using peavey or canthook, the selected pole will be rolled off from the butt end. It is not necessary to rebind the load when continuous distribution is to be made. However, re-binding may be necessary where pole distribution is not continuous where travel is over rough roads.

78. Unloading Poles at Railroad Sidings

The equipment, a list of which follows, should be on hand in good, safe working condition before attempting to unload a car of poles.

(a) Binding line - This is to be made up locally. It consists of a piece of 7/16-inch winch line, 165 feet or more in length. The sketch on page 58 (Figure A) shows a line equipped with choker hooks and also one that is intended to be used with wire rope snatch blocks.

(b) Choker hook or wire rope snatch blocks - Two choker hooks or wire rope snatch blocks are required to facilitate binding the load with the binding line.

(c) Safety stakes - Two of these stakes are required under usual conditions.

(d) Guy rope guards - Two or three of these guards, depending upon the number of safety stakes used, are required for attaching the guy ropes to stake pockets at the back of the car.

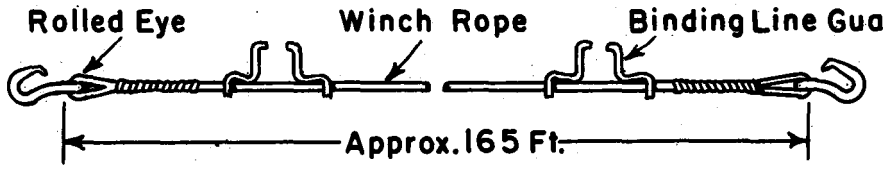
(e) Skids - Two or more substantial skids, of sound timber, are required.

(f) Wire rope snatch blocks - One, two, or three blocks are required, depending upon the method used for pulling up the binding line.

(g) "C" winch rope hook - Two required for making binding line fast to the car axle.

(h) Set of blocks and tackle - A set of 3-sheave, 8-inch blocks and tackle is required to place tension in binding line. Blocks are not required

BINDING LINE EQUIPPED WITH CHOKER HOOKS



BINDING LINE (FOR USE WITH WIRE ROPE SNATCH BLOCKS)

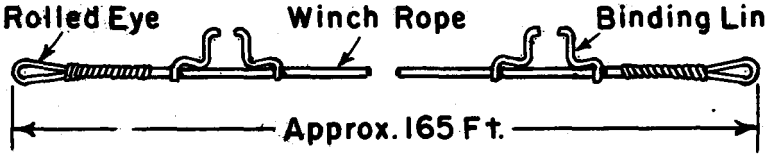


Fig. A

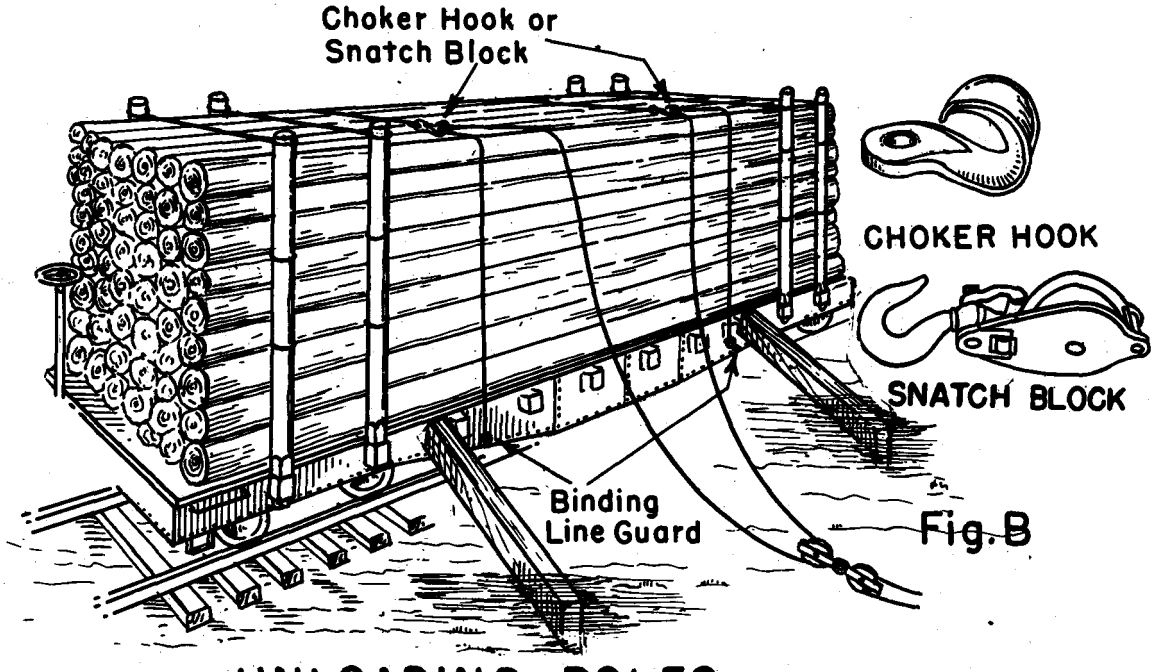


Fig. B

UNLOADING POLES (FLATCAR)

if winch line of motor truck is used for pulling up binding line.

(i) Manila rope, 1-inch or larger - Two pieces, each of which is 50 feet long, are required for guying safety stakes. A third piece, about 50 feet long, is required for attaching to key pole, to assist in starting the load if necessary.

(j) Hand line - a hand line is required for pulling hooks of binding line over the load.

(k) Strand cutter - for cutting the wires on load.

(l) Short ladder - For use in cutting tie wires not easily reached from ground.

(m) Axes - Two are required for cutting the stakes.

(n) Pike poles - Two should be available for handling poles.

79. General Precautions When Unloading Poles

(a) The binding line, ropes, and stakes to be used in this work should be in perfect condition. Under no circumstances should the work be undertaken with a binding line which has broken wires or with ropes which have broken strands.

(b) Strong skids should be placed against the car.

(c) The unloading gang should preferably be a small one. Three or four men and a foreman can unload a car satisfactorily.

(d) All of the orders should be given by the foreman in charge of the work.

(e) Only one operation should be in progress at a time, and the various operations should follow each other in the order indicated.

(f) Nobody should be permitted on the top of the load at any time.

(g) If blocks and tackle are to be used for pulling up the binding line, the anchorage to which they are to be attached should be very substantial. If a

motor truck and winch line are to be used for pulling up the binding line, the wheels of the truck should be blocked. The winch clutch should always be engaged. The winch used for this work should preferably be of a type that will not reverse except under engine power.

(h) If stakes at back of load are broken or load leans toward main tracks, place extra stakes in unoccupied pockets at back of load to reinforce it.

(i) Be sure that the space on unloading side of car is clear of old wire, stakes, etc.,

80. Unloading Flat Cars

For convenience, one side of the car is designated as the "unloading" side, and the other side as the "far" side. The various steps to be taken when unloading flat cars are as follows:

(a) Set the brakes of the flat car and, if necessary, place blocks under the wheels to prevent the car from moving. Place substantial skids against the car on the unloading side. The tops of the skids should be at the level of the floor of the car so that the poles will roll off without interference. The lower ends of the skids should be set in the ground so that there will be no possibility of their slipping.

(b) Pass the two ends of the binding line under the car from the unloading side. Throw a hand line over the load from this side and by means of it draw the ends of the binding line over the top of the load. Connect the eyes of the binding line to the hooks of the snatch blocks and pass the bight of the line over the sheaves of these blocks. If the line is equipped with choker hooks, pass the bight over the hooks. Slide the blocks or hooks into a position on top of the load about one foot back from the nearest pole on the top layer. This work must be done from the ground. Place a wire rope snatch block in the bight of the binding line and pull up the binding line by means of a motor truck winch line, or a set of 3-sheave, 8-inch blocks, until the load is tightly bound. (See drawings on unloading flat cars.)

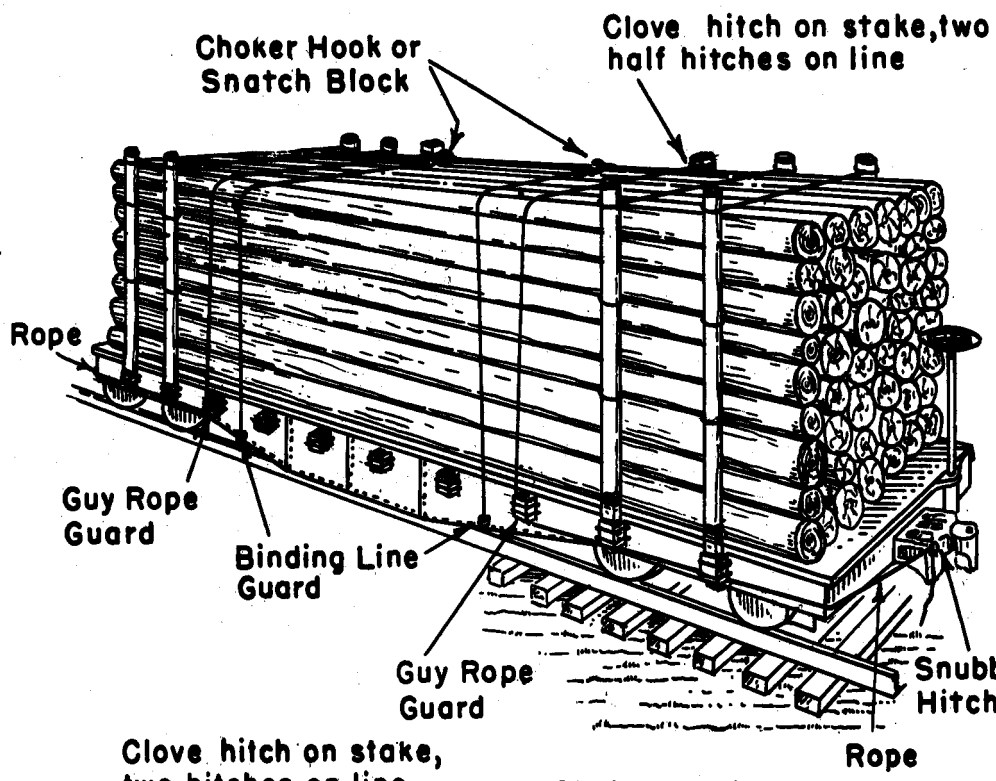
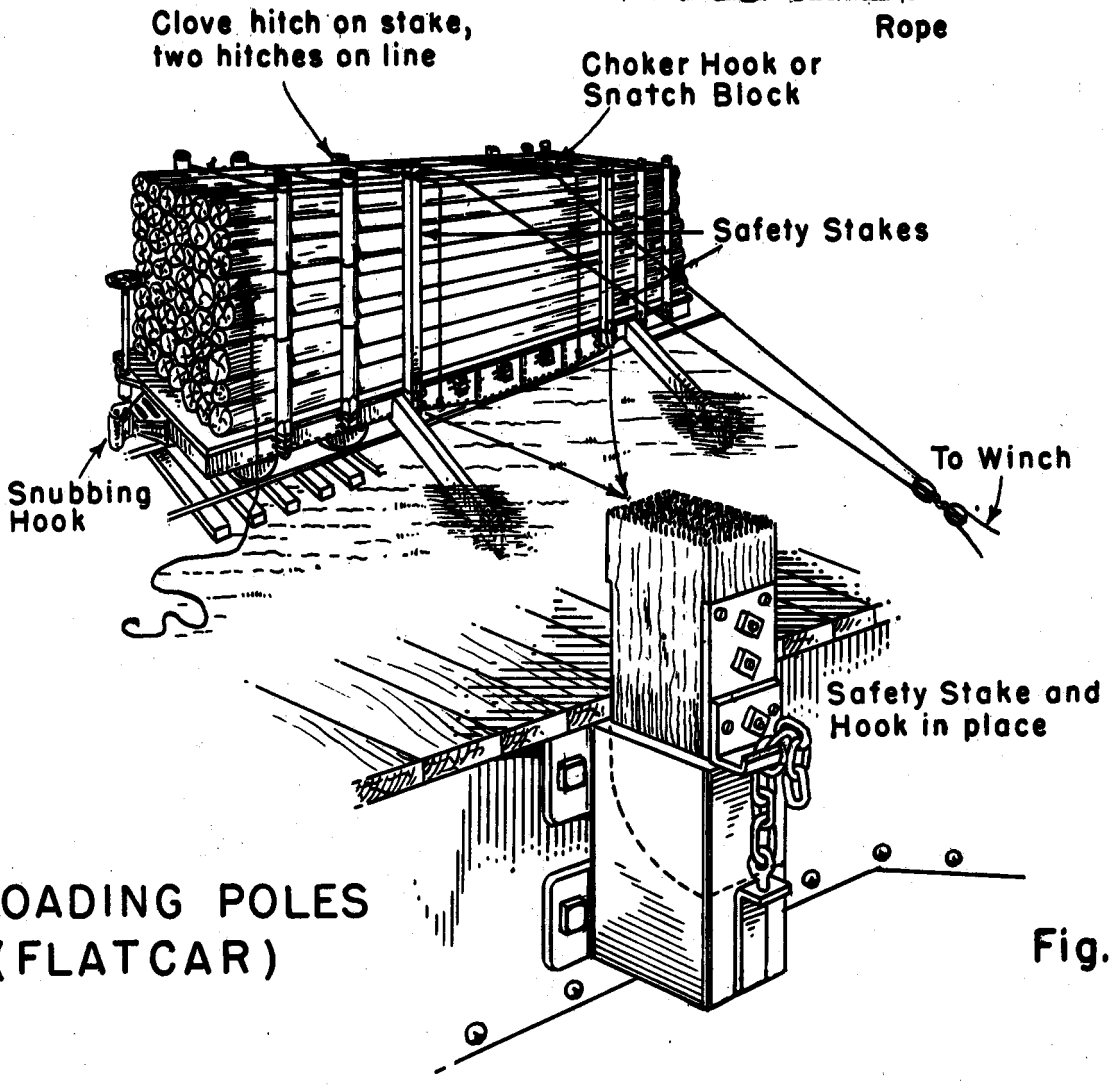


Fig.C



UNLOADING POLES
(FLATCAR)

Fig.D

(c) Tie a 50-foot length of 1-inch or larger rope securely at the upper end of each safety stake. Place the safety stakes in their unoccupied pockets of the flat car on the unloading side adjacent to the existing stakes. Place the safety stake hook which forms a part of the safety stake under the lower edge of the stake pocket and adjust the length of the chain so that the stake cannot be lifted out by an upward pull of the guy rope, but so there will be no interference with the stake's dropping out when the guy rope is released. Pass the guy rope over the top of the load and pull up hand tight. Pass the guy rope around the hook of the guy rope guard which has been attached to a stake pocket on the back of the car opposite the safety stake. Secure the end of the rope at a convenient point in such a way that it can be easily released. (See drawings on unloading flat cars.)

(d) Tie a 50-foot length of 1-inch or larger rope securely to the end of a key pole on the unloading side and lay it out of the way at the end of the car. This rope is for use later in case it becomes necessary to start the load.

(e) Cut the lower wires on the unloading side of the car by means of strand cutter, working from the center toward the ends of the car. If each set of stakes is held by three cross-ties, cut the middle and then the lower ties at each set of stakes. <u>In no case should the top ties be cut</u>.

(f) Chop each stake completely off on the unloading side of the car as close to the stake pocket as practicable, excepting the safety stakes placed in accordance with (c) working from the center toward the ends of the car. <u>Before the last few blows of the axe are struck, stand clear of the stake, so that in case the bottom of the stake should spring out, it will not strike the chopper. Do not cross in front or back of the load after this operation</u>.

(g) After all men are clear of the load, let off the guy ropes holding the safety stakes. After the safety stakes have dropped out of the pockets, pull the stakes clear by means of the guy ropes. All of this work must be done from the ends of of the load.

(h) Let off the tension in the binding line slowly. If the poles start to roll, the tension should be released gradually so as to let the load roll slowly off the car. If the load does not start to roll, hold the binding line with a small amount of slack in it, and start the load rolling by means of the pull rope tied to the key pole, or by means of pike poles, working from the ends of the car.

(i) After the poles have completely settled, remove the snatch block from the binding line. Roll a number of the remaining poles off the car so as to relieve the pressure on the stakes on the far side. This should be done by means of the winch line, a separate piece of rope, or pikes working from the ground. The line may safely be attached to the end of a pole by a workman standing clear of the poles at the end of the load. This man must not climb on the remaining poles for any reason, nor walk along the car in front of the poles.

(j) Care should continue to be exercised in clearing the car and piling the poles, in order to avoid personal injury.

81. Stacking Poles

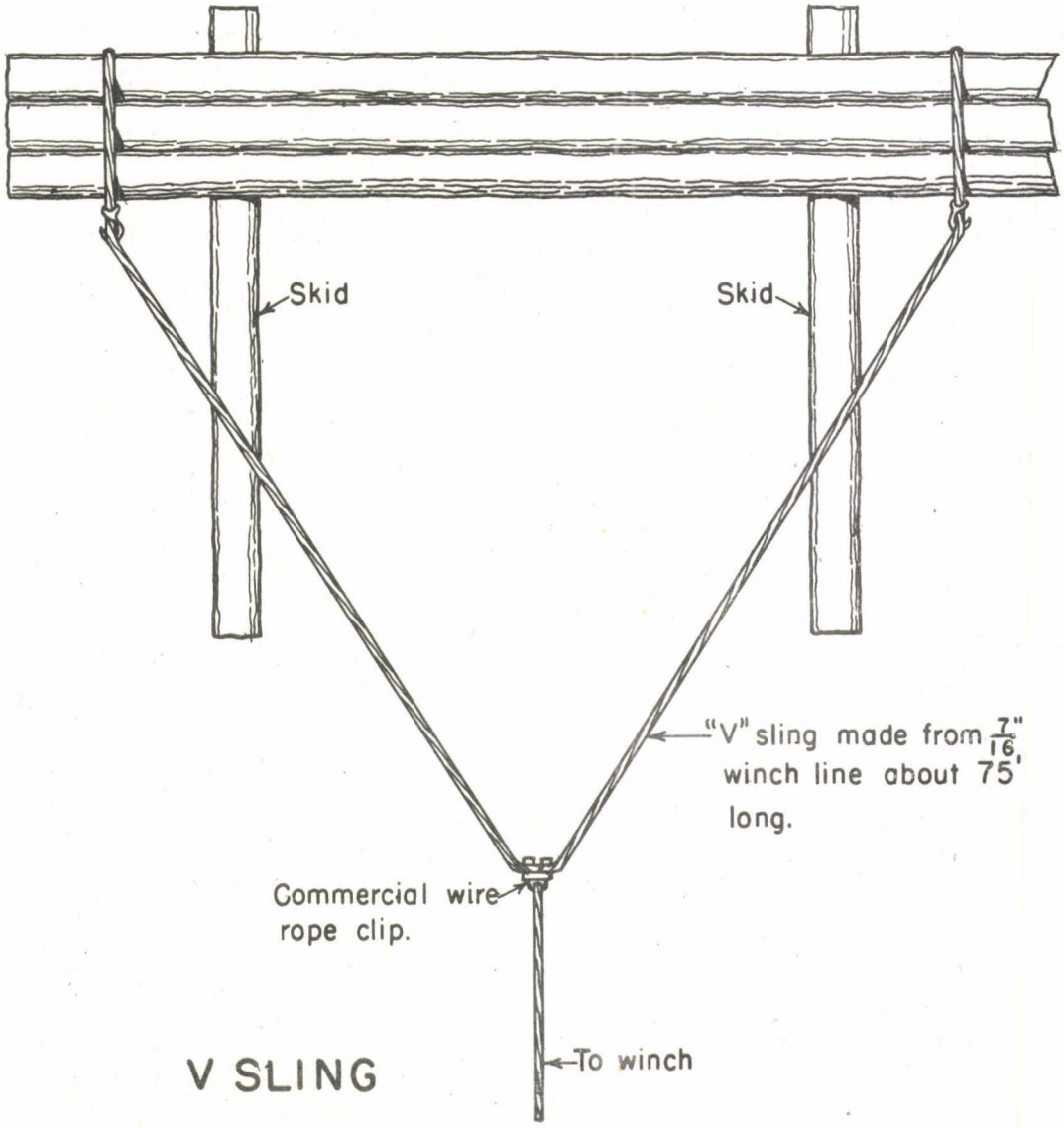
(a) Do not climb on top of poles. Work from the ends of the poles insofar as practicable

(b) Use the winch line for doing the heavy work, particularly pulling the poles off the car.

(c) In connection with the sliding of a considerable number of poles along the skids, it will frequently be advantageous to make use of a "V" sling, such as is shown on next page.

(d) Poles that are to be stored for more than 2 weeks should be stacked on creosoted timber, or equivalent, so that they will be at least 1 foot above the surface of the ground. The storage skids should ordinarily be spaced about 15 feet apart.

(e) Where piles are more than one pole high, each layer shall be carefully nested on the layers beneath. Butts of poles should be reversed on alternate layers when the pile will be four or more layers high.



V SLING

(f) Where poles are to be stored for several months, it would be best especially along a railroad track, to cover the top poles with a layer of mud and dirt to prevent fires from starting. Reduce the fire risk to the pole stack.

(g) If plenty of storage space is available, the poles should be stored in small piles. The storage lot should be free of litter. An adequate fire break, to prevent fires from burning into the stacks from the outside should be made. The investment in stored poles is usually double and often triple the original cost at the plant.

(h) Property notices should be posted at all four corners of the pole lot and at least one notice on each stack.

82. Expansions, Future

To provide for plant expansion, it is essential that the original design, relating to poles, brackets and crossarms, should include provision for adequate strength and length in the pole structure and the need for additional bracket or pin space. Longer poles should be purchased where clearance would be a factor if additional brackets or crossarms were added. The same class of pole should be used for added brackets but where more than two crossarms may be added the pole class should be one higher grade than would have ordinarily been used.

The following should be the guide:

Original Requirement	Anticipated Expansion	Suggested Pin Space
1 metallic circuit	1 circuit to be added	1 set brackets now add 1 set later
2 metallic circuits	none	2 sets of brackets
2 metallic circuits	1 or 2 circuits	1 - 6 pin arm (Use brackets under arm for fourth circuit)
3 metallic circuits	none	1 - 6 pin arm
3 metallic circuits	2 additional	1 - 10 pin arm

83. Permanent Systems

Only the standardized poles in "Material Standards" will be utilized in all permanent telephone lines requiring poles in their construction. Split poles will not be considered. The investment in poles and labor is too great to permit the use of substandard poles that will give less service life. This standard need not be followed for the occasional pole in a tree line where transportation problems make the use of the standard pole impractical.

84. Temporary Systems

Where a telephone system is definitely known to be of a temporary nature and is to be abandoned within a period of 5 years, it is permissible to use poles and materials that are substandard. In such cases it is only necessary to make sure that the line is not a hazard to the maintenance man and to the public where such lines are in public areas. In some instances the degree of service and dependability will not permit deviations from the standard regardless of its temporary nature. In most instances deviations would consist only in using untreated poles.

85. Pole Use

Type of Attachment	Minimum class Of Pole
Tree insulator attachment (slack wire line)	7
Bracket line (Max. 2 Metallic circuits)	6
1 crossarm and 1 bracket pair	5
2 crossarms	5
Cable suspension poles	5
Joint power distribution and cable suspension	4
H Frames for long span const.* 500' or more	3

*The class of pole used here will vary according to the length of span and should be calculated for all spans in excess of 500'.

Pole lengths will depend upon individual line grading requirements. The average pole length will be 22 feet. See line grading and crossings for special considerations affecting pole lengths.

In addition to the above, consideration should be given to the following practices:

(a) The best-shaped poles are selected for those locations where good appearance is a factor, if other considerations are equal.

(b) Designate the largest available poles for use at dead-ends, corners, junctions, and at locations where poles are to carry a heavy load.

86. Distribution of Poles

(a) The poles should be left as close as practicable to the stakes and in such a position that they can be handled conveniently by the erection crew. Where poles are to be erected by manpower, it is desirable, where possible, to have them arranged with the butt close to the stake. Where holes are to be machine bored, deliver the pole to the point near the stakes, but sufficiently removed so that there will be no interference with operation of boring machine.

(b) Be sure poles are left so as not to interfere with drainage or traffic, or be a hazard to the public or to animals.

(c) Piling of poles along a route should be avoided where practicable on account of the extra handling required and the possibility of accidents resulting from poles rolling off the pile; also to prevent destruction by fire.

Where necessary to move treated poles over rough terrain, a sled or similar device should be used.

If the poles are sufficiently light, they may be loaded on to the distribution conveyance by hand. However, it may be desirable to use either a pole derrick or gin pole for safety purposes and to expedite the loading.

87. Steel Poles

The use of steel or metallic poles should be limited to those installations where, due to solid rock formation or other reasons, their use is more feasible than the standard wooden pole. Tubular steel or channel iron types are satisfactory and the load requirements determine the size and weight of material.

Where lines follow closely to sheer rock cliffs or walls, the elimination of a pole is sometimes practicable, substituting in its place a steel bracket for attachment of the cross arm. Such attachments should never be made where the cliff is likely to release boulders that will damage the line or endanger the workmen. Local designs involving steel poles and special brackets should be checked by competent mechanical authority in the division of engineering before proceeding with procurement of materials.

88. Stubbing

In some instances stubs have been used at the time of the original construction. Such practice is not considered standard and for the class of pole used on Forest Service lines the cost of the treated stub and the attachment problem increases the cost beyond any advantage gained.

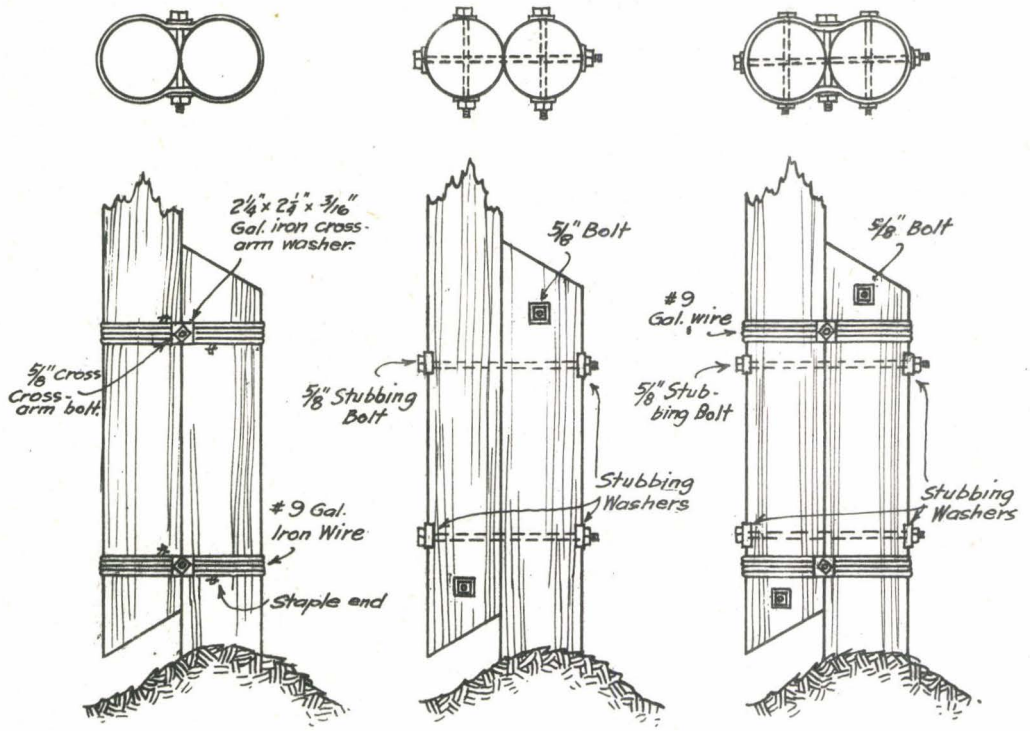
Stubbing of poles that have rotted below the ground but are still in good condition above the ground has been successful in some instances. Determination of stubbing versus the setting of a new pole will be based upon the following:

(a) The pole above ground must be in good condition and as serviceable as the stub being attached.

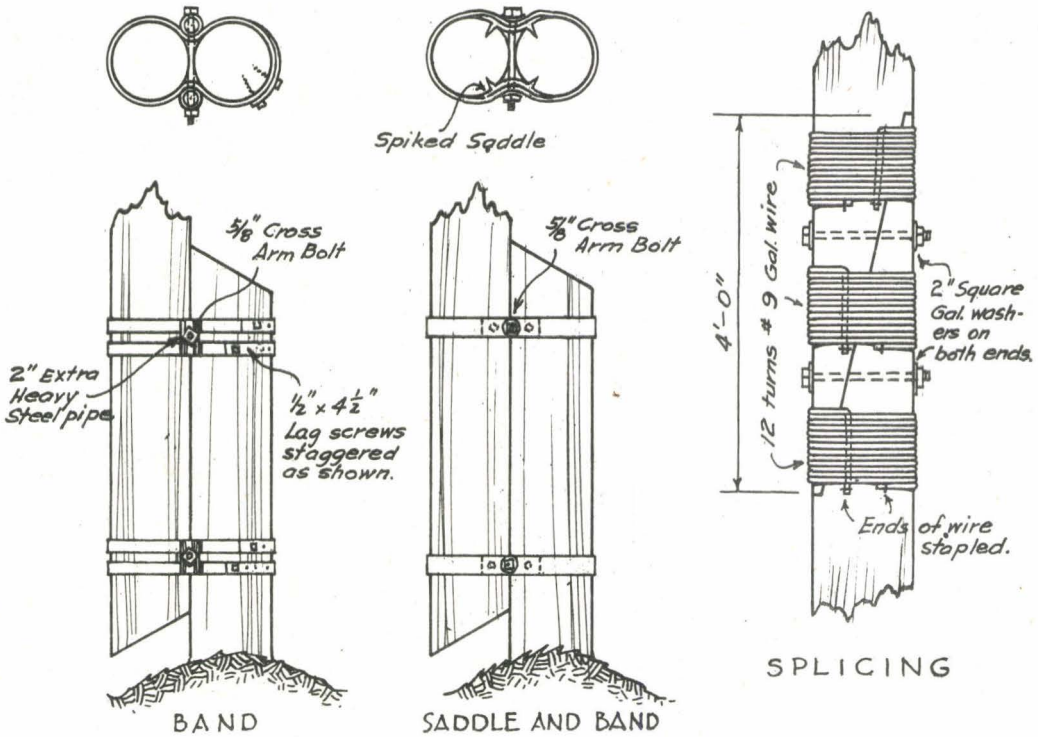
(b) The moving of a large number of attachments on the pole (crossarms, brackets, arresters, cable and guy attachments, etc.) would involve considerable labor and may dictate the use of a stub if (a) above is met.

In general, stubbing should not be used in lieu of complete pole replacement.

The diagrams on stubbing and splicing methods show different methods of stubbing all of which are satisfactory. However, the bolt method, because of its simplicity, is the most desirable, with the band method next.



WIRE WRAP | BOLT | WIRE WRAP AND BOLT


Spiked Saddle
5/8" Cross Arm Bolt
2" Extra Heavy Steel pipe
½" x 4½" Lag screws staggered as shown.
5/8" Cross Arm Bolt
4'-0"
12 turns #9 Gal. wire
2" Square Gal. wash-ers on both ends.
Ends of wire stapled.

BAND | SADDLE AND BAND | SPLICING

Either band or bolt method are preferable to the others

STUBBING AND SPLICING METHODS

89. Splicing poles

Splicing of poles should not be considered except when standard poles lack sufficient height, such as water crossings, use method shown on page 69.

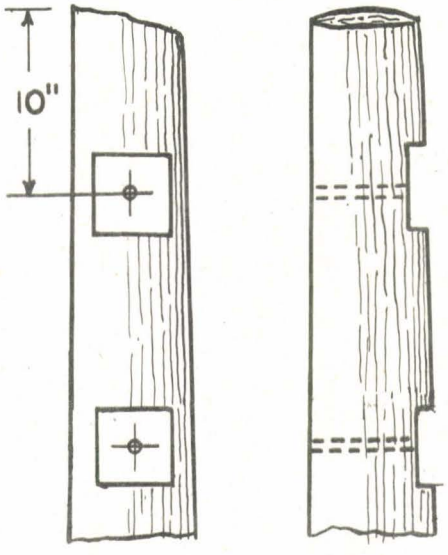
90. Framing Poles

Framing is the cutting of gains, boring of holes, and performing of other carpentry work on poles and other supports.

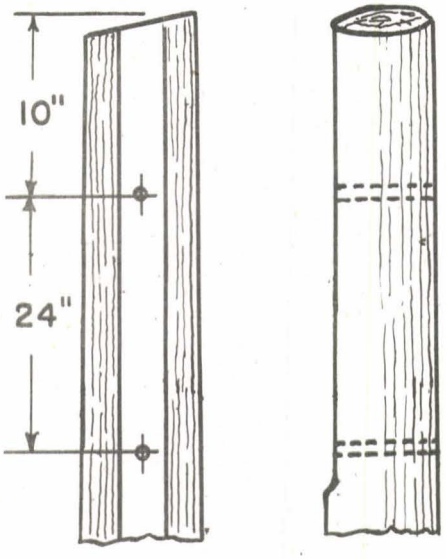
When poles are ordered from commercial suppliers, it should be specified that they be slab-gained 3/8 inch deep and drilled. However, do not attempt to cut a gain after a pole has been treated. For hand gaining of untreated poles, use a carpenter's saw, cutting into the pole not more than 1/2" at the deepest point at both top and bottom of the gain location. Then, with a 2-inch wood chisel and hammer, chip out the gain to the proper depth, the gain should be flat or slightly concove to prevent the arm rocking. The hole should be bored 11/16 inch in diameter, using a wood bit and brace. See drawing below.

STANDARD FRAMING

Untreated Poles



Treated Poles



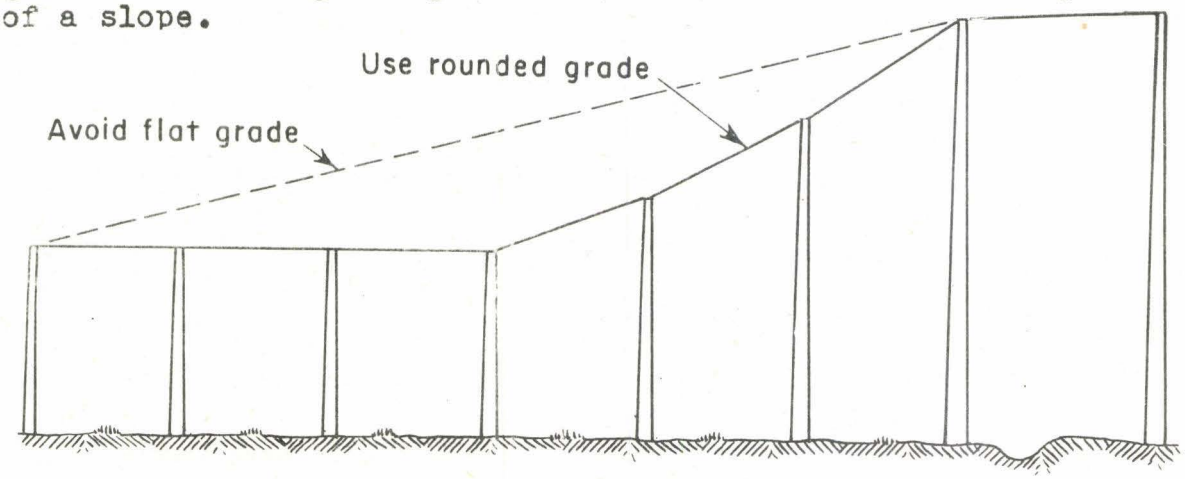
For untreated poles supplied without gains and holes, mechanical means should be used to do the gaining and boring. This should be accomplished, if possible, at the concentration yard. Hand gaining should be done only as a last resort. Locate gains for crossarms on the inside sweep of poles which are curved. Gains should be on only one side of double-armed pole. Only one pole in an "H" structure should be gained. This is necessary to permit leveling of crossarm. The ungained pole in the "H" frames should be smoothed off to provide a good bearing space for the crossarm. Where poles have been previously gained, it will be necessary to match the gains by adjustment in pole setting. Roof poles at right angles to gained face, 1/4 the diameter.

91. Pole Grading, Vertical Alignment

Grading or adjustment of vertical alignment is important in securing construction that minimizes undue pole and insulator strains at grade breaks and if properly carried out will minimize the number of random length poles required to secure reasonable grade changes at each pole.

A line should follow the general contour of the ground over which it passes, avoiding, however, by shortening or lengthening the span, any abrupt dips or rises which would cause excessive pull on tie wires, pins, or other attachments on the pole. In all cases, poles should be made as short as the required clearances and allowable change of grade 15% of span length will permit.

Where it is necessary to increase or decrease the height of attachments on poles, in order to obtain required clearances, the change shall be made by using "rounded" grades, rather than "flat" grades. A "rounded" grade is a grade which has a change of grade on practically every pole, whereas a "flat" grade has a change of grade only on the first and last poles of a slope.



POLE GRADING

92. Poles - Erecting (Hand)

Good working plans will provide for poles to be erected as soon as practicable after the holes are dug. This will eliminate caving and reduce physical hazards to people and animals.

The success of the pike pole method of setting poles, and the safety of employing it, depend upon the intelligent cooperation of the men. Each man should be assigned a definite part of the work and should make himself proficient in it. Do not wear climbers or body belts while piking poles. Make certain that footing is secure before attempting to raise the pole. Nothing should be left under foot which would be an obstacle to raising the pole or contribute to an accident.

Light weight poles, 25-foot and smaller, may be set without the use of a deadman or canthooks. Two pike poles are sufficient. Use butting board.

For medium-weight poles, 25 to 35-foot, proceed as follows:

(a) Place butting board, preferably 1" x 6", or digging bars (in firm soil only) in the hole on the side opposite the butt of the pole.

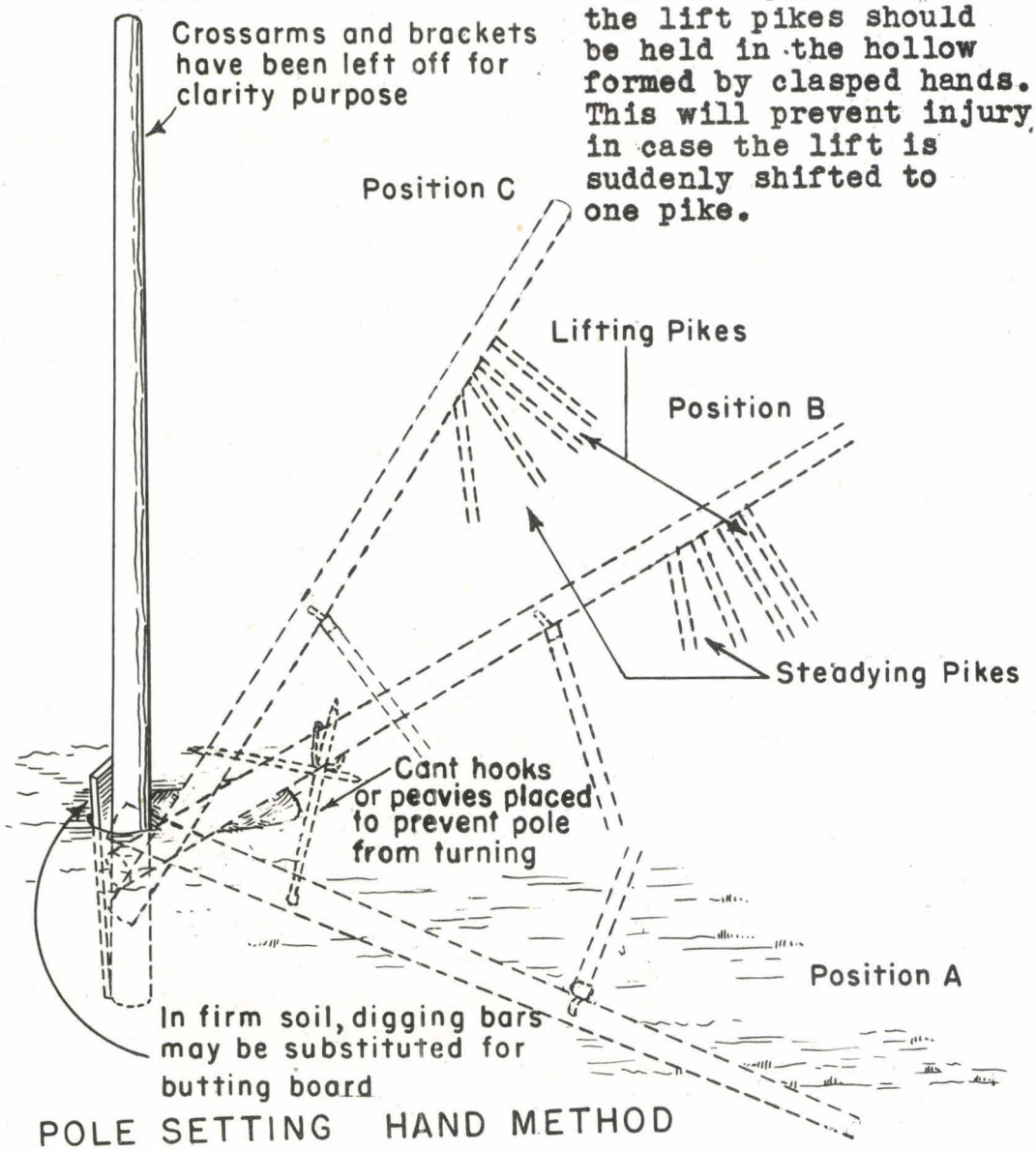
(b) Move pole into position with the butt against butting board or bars. When using a bar, a small "V" notch cut in butt of pole will prevent its slipping off the bar.

(c) Place "deadman" or "jenny" on the ground near the top of the pole and approximately at right angles to the pole. The fork of the deadman should be against the pole and the footing should be at a point where it will not slip when the pole is lifted and the weight is supported by deadman. (Position A). Station a man to guide the deadman as the pole is lifted and to prevent its slipping either along the pole or on the ground. The man handling the deadman should, at all times, avoid standing directly under the pole.

(d) With sufficient manpower, lift pole and deadman to Position B.

(e) Place a man about two feet above probable ground line holding two canthooks or peaveys, one to pull against the other, to prevent the pole from turning as it is being raised.

(f) Place Pike poles near the top of pole, one on each side to steady the pole as it rises and the others distributed slightly to each side to do the lifting. At this stage, the side pikes should be held with the two hands separated and the lift pikes should be held in the hollow formed by clasped hands. This will prevent injury in case the lift is suddenly shifted to one pike.


Crossarms and brackets have been left off for clarity purpose
Position C
Lifting Pikes
Position B
Steadying Pikes
Cant hooks or peavies placed to prevent pole from turning
Position A
In firm soil, digging bars may be substituted for butting board

POLE SETTING HAND METHOD

(g) Raise the pole, moving the deadman forward with the lift to furnish support to the pikes. (Position C.) In changing the location of the deadman, keep it in instant readiness to support the entire weight of the pole.

(h) Apply pikes further down the pole. (Position C.) Shift the pikes one at a time. Raise the pole again. When the pole passes the 45° angle, the men on lift pikes may work to better advantage if they use one hand to support the butt of the pike at the level of the shoulder and the other hand to guide the pike.

(i) Repeat this operation until the pole can be piked directly into the hole. When the pole commences to slide into the hole, remove the deadman so that it will not interfere with the movement of the pole. Care should be exercised not to depend too much on the deadman as it is moved toward the center of the pole.

(j) "Cant" the pole into proper position with canthooks or peaveys and line it up with pikes while backfilling the tamping.

93. Tools required for raising poles by hand

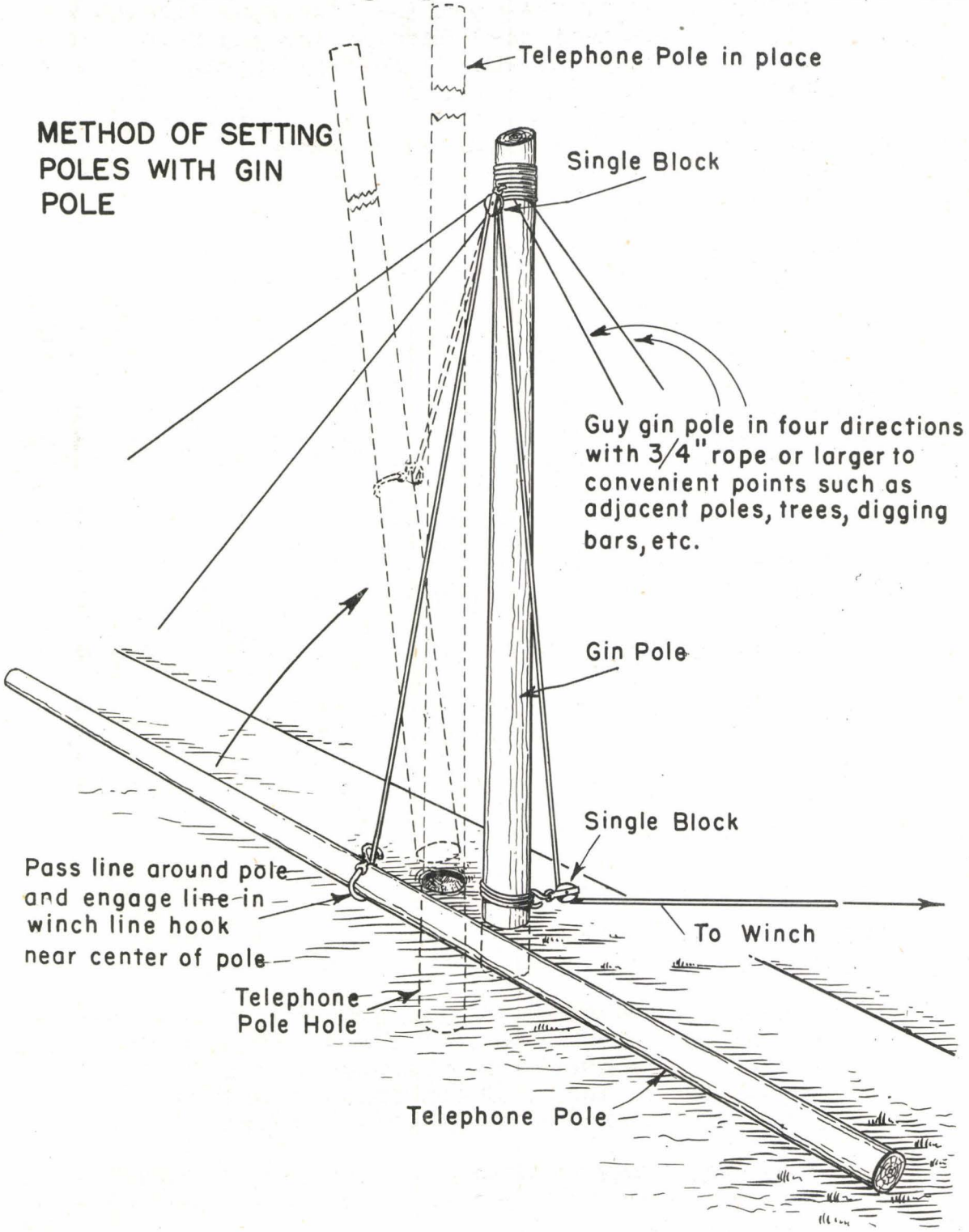
1 Axe, single bit, 3- 1/2-lb.
1 Bar, 8', digging - or butting board, 1"x6"x8'
2 Canthooks
1 Deadman, 8'
4 Poles, pike, 10', light-weight
2 Poles, pike, 14', light-weight
2 Shovels, LHRP
1 Tape, Steel, 50'
2 Tamping bars
3 Timber carriers

94. Erecting Poles (with Gin Pole)

This method is used when a pole is too long or too heavy to permit the use of the pole derrick or pike poles, or when the construction gang is too small to use pike poles and a pole derrick is not available. When using a gin pole a power-winch is recommended on account of the greater

convenience and in order to avoid the use of the large amount of rope that would be required if pulley blocks are used. When setting poles with the gin pole, proceed as follows:

(a) Erect a gin pole suitable length (class 5 or larger) as close as practicable to the hole which has been dug for the line pole. Where conditions permit, the butt of the gin pole should be set in a shallow hole


METHOD OF SETTING POLES WITH GIN POLE
Telephone Pole in place
Single Block
Guy gin pole in four directions with 3/4" rope or larger to convenient points such as adjacent poles, trees, digging bars, etc.
Gin Pole
Single Block
Pass line around pole and engage line in winch line hook near center of pole
To Winch
Telephone Pole Hole
Telephone Pole

to prevent it from slipping. Where conditions make it preferable, the butt of the gin pole may be guyed four ways rather than setting it in a hole. Where there will be no tendency for the butt to slip, it may be set on the ground, or on a plank if the soil is soft. The butt should, in all cases, be supported if the pulling line runs through a snatch block near the base of the gin pole. The length of the gin pole should be sufficient to permit attaching the snatch block or upper pulley block at a distance above the ground about 2 feet greater than the distance between the butt of the line pole and the point on the pole at which the winch line or sling will be attached.

(b) Guy the gin pole, as shown in diagram on the preceding page.

(c) Attach two 8" x 1-1/4" snatch blocks; one near the top of the gin, the other near the bottom.

(d) Run the winch line through the snatch blocks and attach the end just above the balance point on the pole to be raised.

(e) Raise the pole, guiding it as it rises, by applying pressure on the butt until the butt is directly over the hole. Where power transmission wires are adjacent, precautions must be taken by:

(1) Preventing pole's contacting power wires.

(2) Using short piece of rope tied around the butt with ends dangling, and a man to hold each end (don't touch the pole with hands or body or any metallic tool).

(3) Using rubber gloves where necessary to handle by hand.

(f) Lower the pole into the hole.

(g) Line up the pole with canthooks and steady it with pike poles.

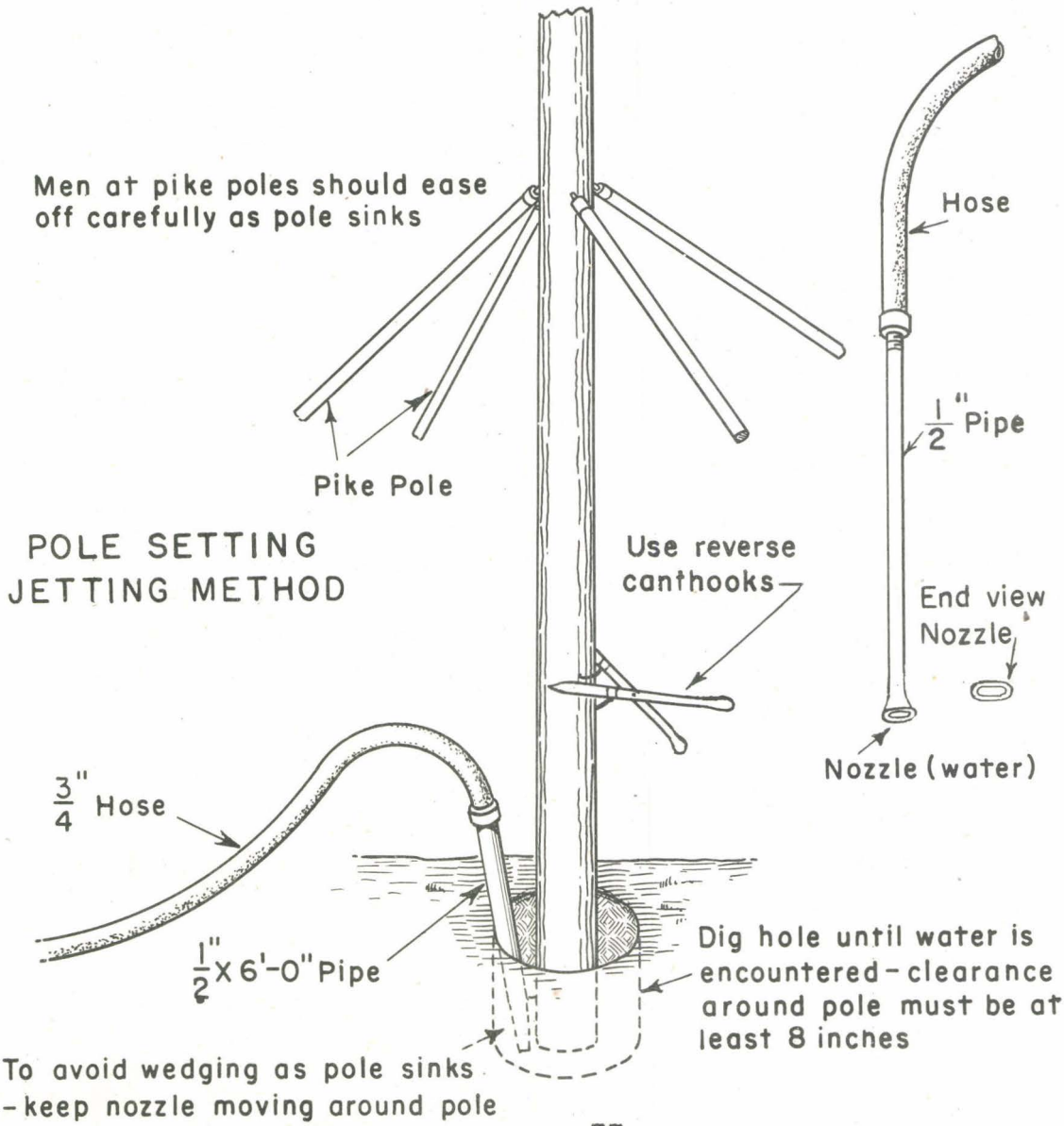
(h) Back-fill and tamp thoroughly with tamping bar around the pole. All or the soil thrown into the pole hole must be thoroughly tamped from the bottom to the top of the hole. Any excess dirt may be piled around the pole and tamped.

(i) Rope tackle may be used as above, but it is not recommended where power can be made available.

95. Poles, Setting (with the Water-Jet Method)

Where digging holes to the full depth by hand tools is impracticable because of caving soil or subsurface water, a jetting method may be used. To use this method, a water pump with a capacity sufficient to furnish a 1/2-inch stream of water, with a minimum nozzle pressure of 25 pounds, together with a 50-foot length of hose equipped with a 6-foot piece of 1/2-inch pipe flattened on the end to produce a flat discharge, and an adequate supply of water (approximately 50 gallons per pole), is necessary. Pacific-Marine, Hercules, or Panama fire pumps would be satisfactory for this purpose.

(a) Dig hole of sufficient diameter to give approximately an 8-inch clearance around the pole until the soil begins to cave or until water is encountered; then mark the pole at the proper depth line.


Men at pike poles should ease off carefully as pole sinks
Pike Pole
POLE SETTING
JETTING METHOD
Use reverse canthooks
Hose
1/2" Pipe
End view Nozzle
Nozzle (water)
3/4" Hose
1/2" X 6'-0" Pipe
Dig hole until water is encountered - clearance around pole must be at least 8 inches
To avoid wedging as pole sinks - keep nozzle moving around pole

(b) Set the pole in this hole and keep it upright by four men, each with pike pole, holding with one hand at the bottom and the other about 3 feet higher.

(c) Direct a stream of water from the nozzle, working it around the pole and up and down simultaneously to prevent wedging. The pole is gradually undermined and sinks. During this operation, the men should ease off on the pike poles.

(d) When the pole has sunk to the desired depth, reduce the flow of water, remove the nozzle, and shut off the water entirely.

(e) Line up the pole with canthooks and steady it with pike poles.

(f) Shovel back the overflow of sediment around the pole. Usually no tamping is required.

(See drawing, Pole Jetting)

96. Rake of Corner Poles

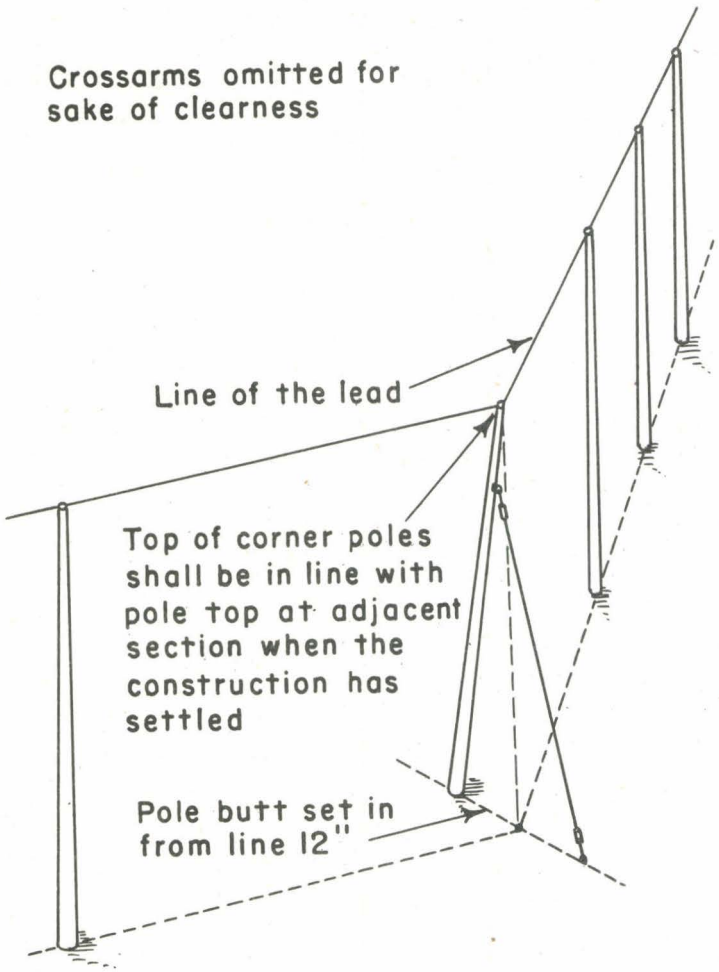
It is desirable that guyed or unguyed corner poles be raked. H-Fixtures shall not be raked. Conditions in towns or cities may require that all poles be set vertically. Rake is provided by "setting in" the butts approximately one foot. (See Diagram). This may be exceeded, however, by 50 per cent where the poles carry a heavy load. Dead-end poles should have a slight rake in line with the lead.

In raking, extend the top of the pole sufficiently beyond the line to allow it to come back into line when strain is applied. Normally, an allowance equivalent to the diameter of the pole is adequate.

Allowance should be made for all ground braced poles or stubs, any length, to have a rake of 1 foot after construction has settled.

Rake all poles supported by push braces the same as for guys.

Give guyed stubs as much rake as clearance conditions will permit.


Crossarms omitted for sake of clearness
Line of the lead
Top of corner poles shall be in line with pole top at adjacent section when the construction has settled
Pole butt set in from line 12"

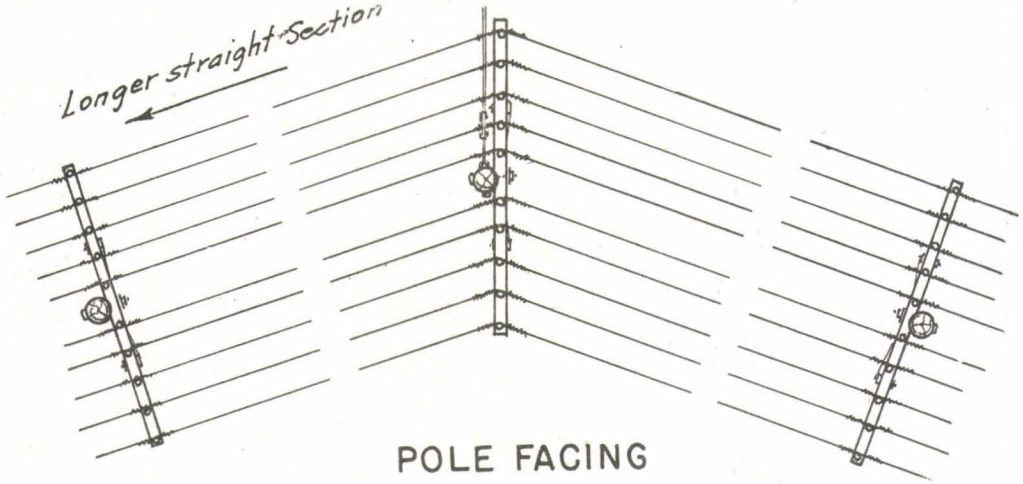
CORNER POLE RAKED

97. Backfilling and tamping

It is important that the earth be tamped thoroughly for the full depth of the hole. Two tampers and one man shoveling is a good combination. If practicable, avoid backfilling with frozen ground. When snow is on the ground, precautions should be taken to keep snow from mixing with the earth that is tamped back into the hole. Where conditions permit, coarse soil or gravel should be used at the top of the hole. Rock should be wedged firmly around poles that are set in solid rock. Bank the earth around the pole above the ground level and pack firmly. Be careful, however, not to bank it above the creosote on butt-treated poles.

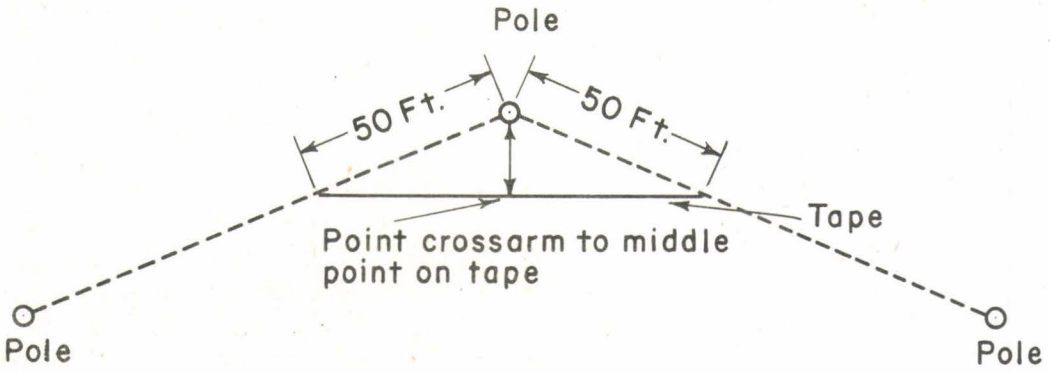
98. **Pole, Facing**

The face of a pole is the side on which the crossarm is attached.



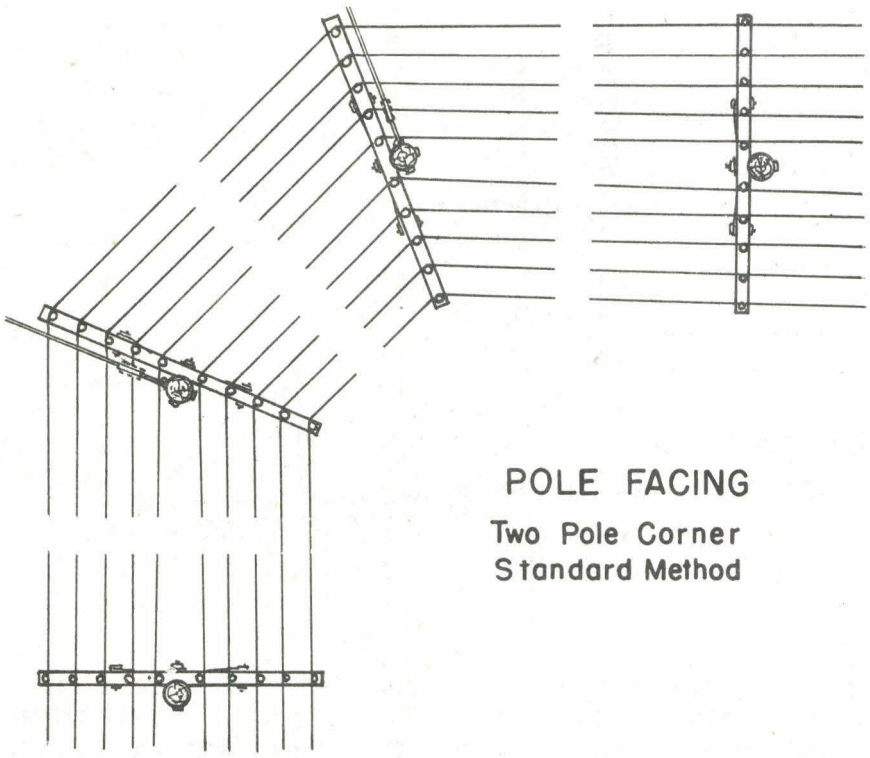
POLE FACING
SINGLE CORNERS

At single pole corners, face the poles so that the crossarms will bisect the angle and will be on the face of the pole away from the longer straight section of the line. Crossarms on the poles adjacent to the corner shall face toward the corner pole.



METHOD FOR LINING UP POLE FACE CROSSARM

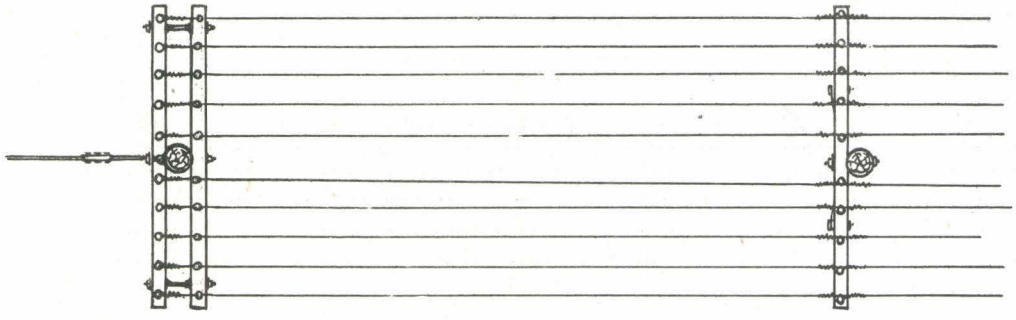
A crossarm bisects the angle in the line when it points to the mid-point of a tape line stretched between two points laid off a convenient distance, 50 feet, for example, along the lead in both directions from the corner pole.



POLE FACING

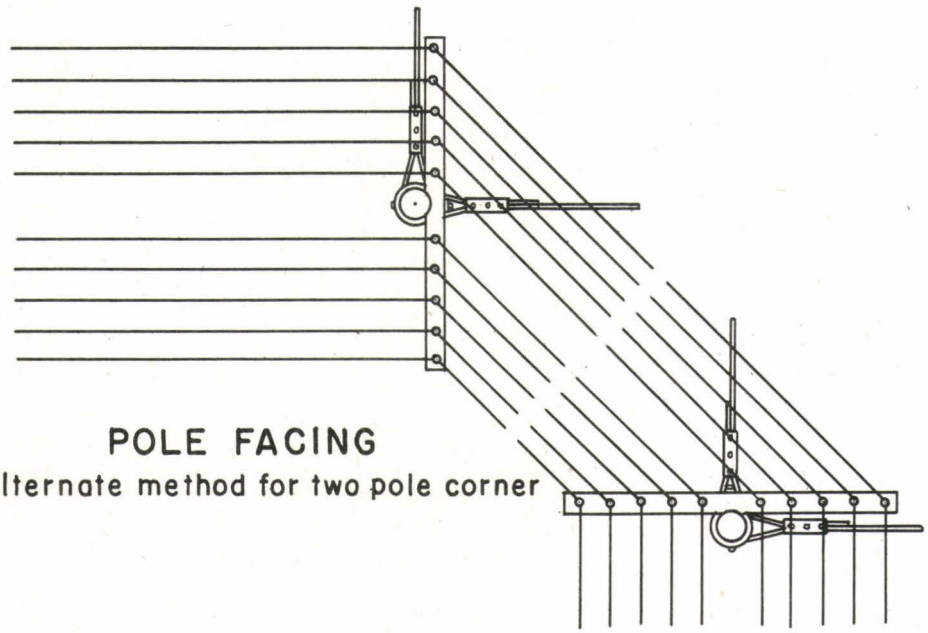
Two Pole Corner
Standard Method

At two-pole corners, face the poles so that the crossarms will bisect the angle at each pole and so that the crossarms will face away from the adjacent straight section of line. Crossarms on the poles adjacent to the corner shall face toward the corner pole. See next page for alternate method.



POLE FACING Open Wire Dead-ends

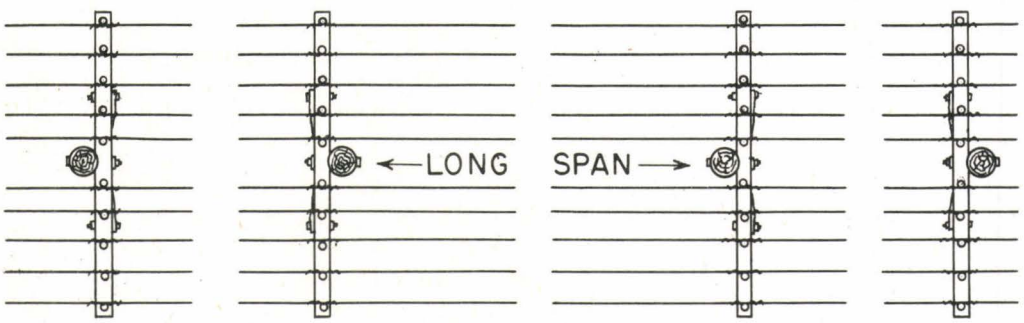
At open wire dead-ends, using terminal brackets, set the pole with the face away from the last span. It is preferable for the pole face to be likewise for double arm fixtures. Set the pole next to the dead-end, with the face toward the dead-end.



POLE FACING

Alternate method for two pole corner

In cities and at other points, it may be impossible to locate guys properly as shown in "Two Corner Pole" page 81. Where this condition exists, face the crossarm at right angles to the straight section of the lead and guy with head or back and side guys, as shown above.



Face the poles supporting a long span away from the span.

ATTACHMENTS, POLES

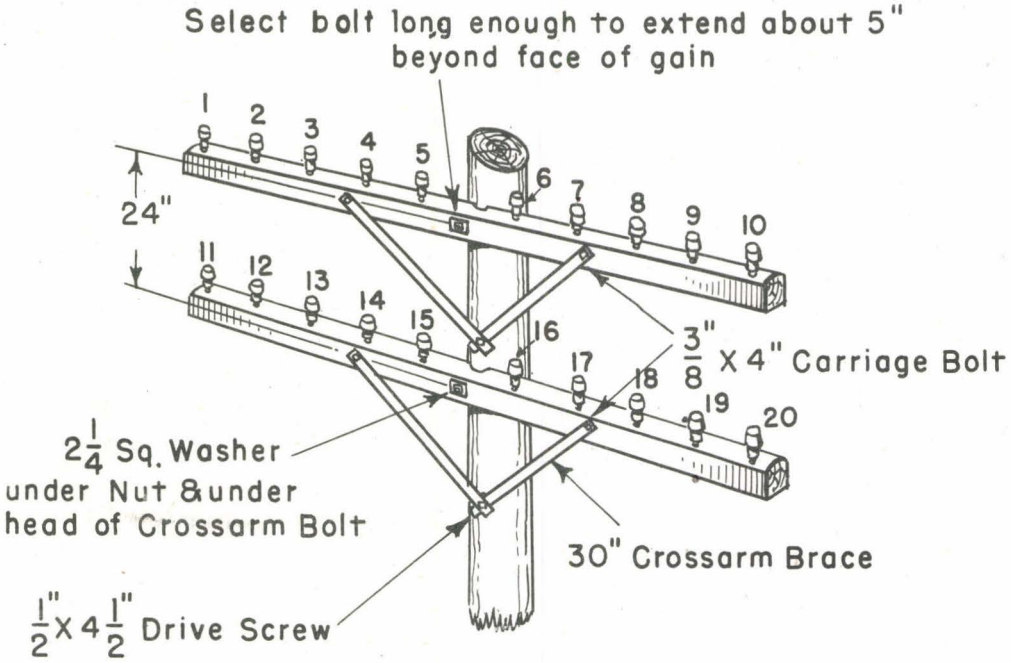
99. Crossarms

Crossarms with braces should be attached to the poles, where possible, before erection. The following steps should be taken:

(a) Select cross-arm bolt long enough to extend about 5 inches beyond face of gain without cutting into the back of the pole.

(b) Place a 2-1/4 inch square washer on the bolt and drive the bolt into the hole from the back side. Then, turn pole a quarter turn, placing block of wood under head of bolts to prevent their falling back as crossarm is placed over bolt.

(c) Place the crossarm over the bolt with the braces away from the pole.



(d) Place a 2-1/4-inch square washer over projecting end of bolt and turn the nut firmly into place with wrench.

(e) Line up the crossarm, using one of the following methods:

(1) If the pole is on the ground, place the short leg of a steel square on the bottom side of the crossarm, with the heel of the square directly under the bolt, in such a position that the outer edge of the long leg points along the center line of the pole toward the butt. Place a nail or similar object in the center of the pole, at a point 6 feet from the butt, and move cross-arm until long leg of square points toward nail or object.

(f) Where crossarms are to be installed after pole has been erected, use the method of putting up arm as outlined:

(1) Place cross-arm bolt in proper hole before arm is pulled up.

(2) Attach pulley over top of pole with 3/8-inch rope, 18 inches long, in loop fashion.

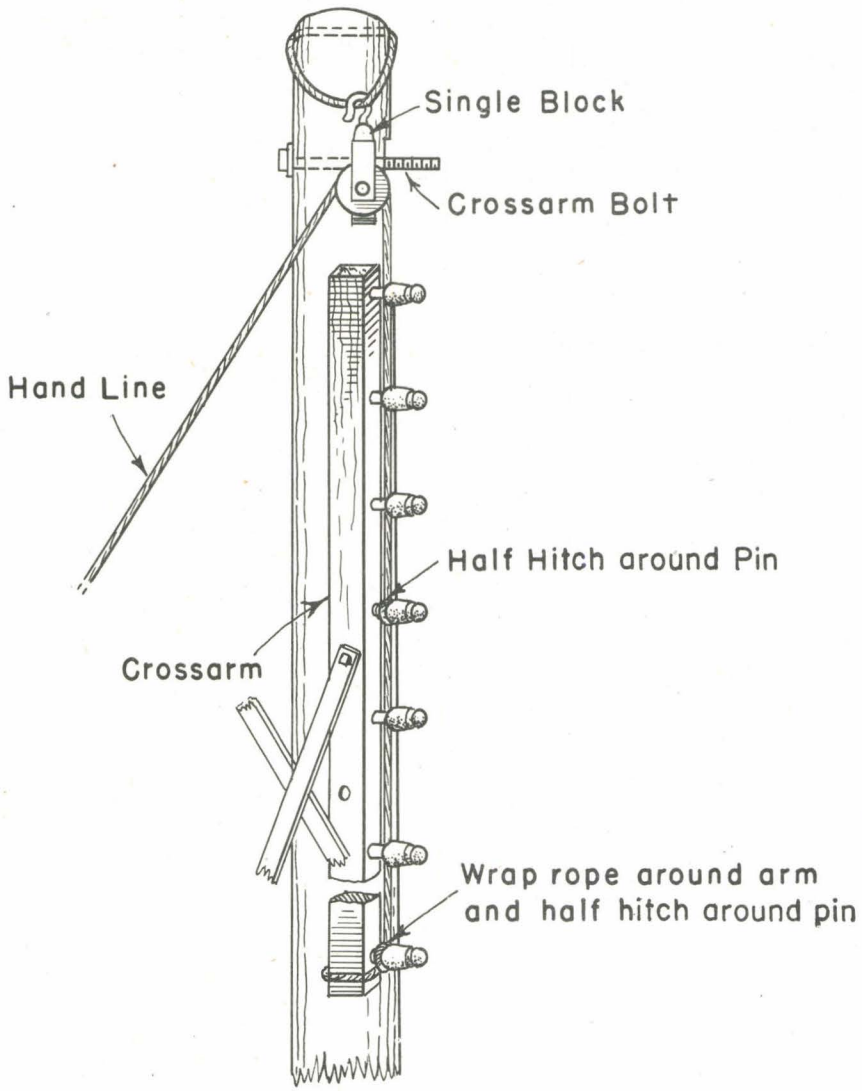
(3) Attach end of hand line to proper end of crossarm and to the fourth pin from the top. On a 10 pin arm or the 3rd pin on a 6 pin arm.

(4) Man on ground hoists crossarm to top of pole following instructions given to him by man on pole.

(5) Man on pole guides the arm to the cross-arm bolt and suspends arm by handing top pin over bolt, after which, he removes the hitch from the third pin and instructs man on the ground to pull slowly, keeping the arm on the outside of his safety strap until it can be eased down and balanced across the belt, which is slightly below the gain.

(6) The hand line is now slacked off and the lineman slides the arm to center the hole with the bolt and then lifts it sufficiently to slide it onto the belt.

(7) Place the washer and nut on the bolt and tighten.



PULLING UP CROSSARM

(8) After the crossarm has been lined up by sighting from the ground, on the face side of the pole, a span's distance away, bend crossarm braces sufficiently to allow the ends to hang free against the pole. Bring the ends together so the two holes register, and attach the braces to the pole with a 1/2" x 4-1/2" fetterdrive lag screw.

100. Double Cross-Arms

Place double cross-arms at the following locations:

(a) Railroad crossings other than at street railways.

(b) Poles supporting long-spans in excess of 500 feet.

(c) Storm head guyed poles or fixtures, in heavy and medium loading areas, where the wires are No. 12 or larger.

(d) At corner poles where No. 10 or larger wires are carried and the pull is 30 feet or greater, and at corner poles where wire is smaller than No. 10, and the pull is 40 feet or greater.

(e) Double arms should be assembled by laying one arm on its side, placing two double-arm bolts as spacers on top side of the arm, then placing the other arm on top of the bolts and inserting the cross-arm bolt in through-bolt of both arms, lining up the arms, one directly over the other, then boring 11/16-inch hole through both arms 10 inches from the end.

(f) Insert cross-arm bolt in this hole and drill hole in similar location at the opposite end.

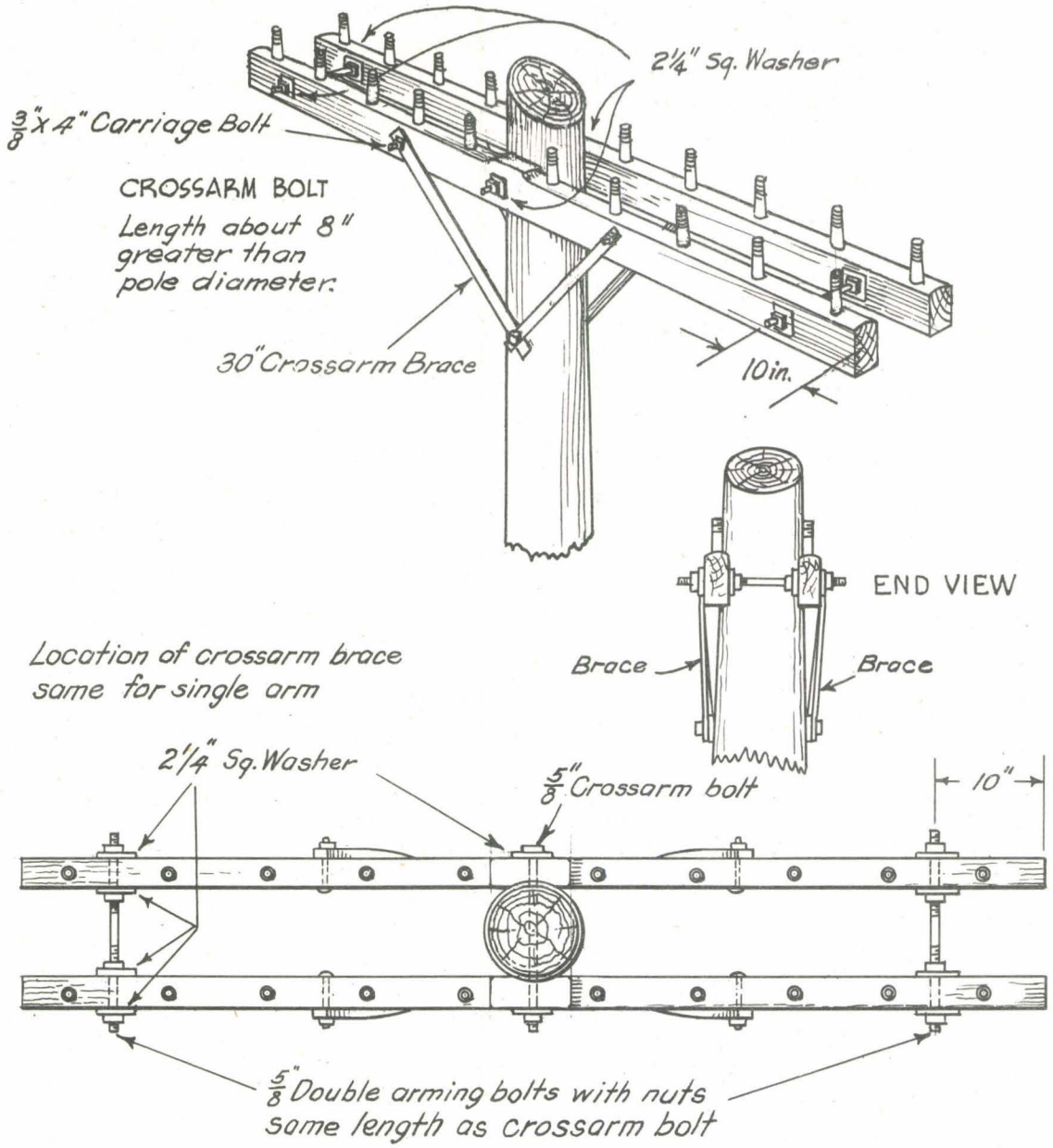
(g) Measure diameter of pole, from gain to opposite side; set nuts on a double-arm bolt this same distance, allowing for washers, and insert in double-arm hole; turn outer nut tight against washer. Duplicate this procedure for opposite end.

(h) Insert cross-arm bolt through center hole and place (if pole is on ground) on the bottom side of pole, extending cross-arm bolt through pole (if pole is erected place first arm on ungained side of pole); then other arm over bolts and tighten.

(i) Line up crossarms, using procedure described under "Crossarms and Braces", page 87.

(j) Lag braces and tighten all bolts and nuts.

(k) A 2-1/4-inch square washer should be used between all nuts and wood, and should be placed square with the crossarm.



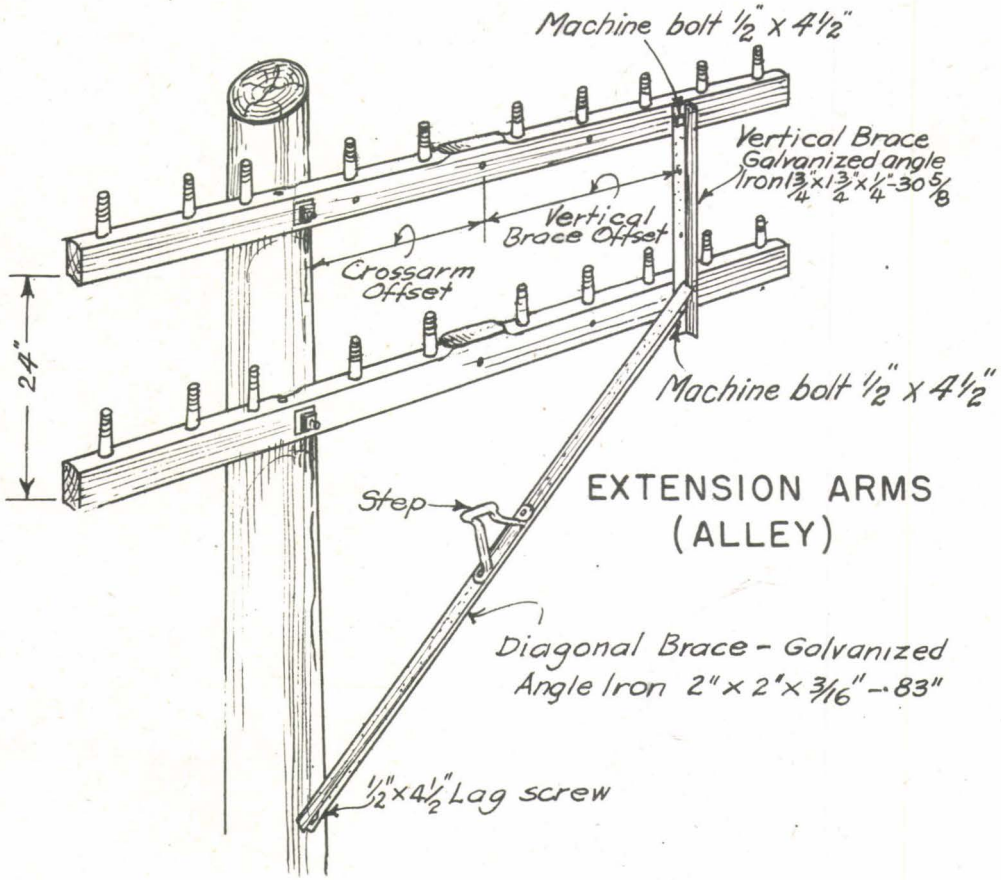
DOUBLE CROSSARM

101. **Extension (Alley) arms**

Extension arms are used to clear trees, buildings, or other obstructions, or to keep the wires in line where it has been necessary to place a pole out of line. The extension arms are usually placed after the pole has been erected. Pins should be respaced to provide climbing room where necessary.

(a) To properly install extension arms, first determine the amount of offset necessary; then bore the through-bolt hole at the proper place in the arm.

(b) The cross-arm braces should be detached and the 1/2-inch bolt holes for the extension arm brace should be drilled and the brace attached loosely. The hole should be drilled at a point in the crossarm to permit the brace to extend at a 45° angle between the pole and the cross-arm.

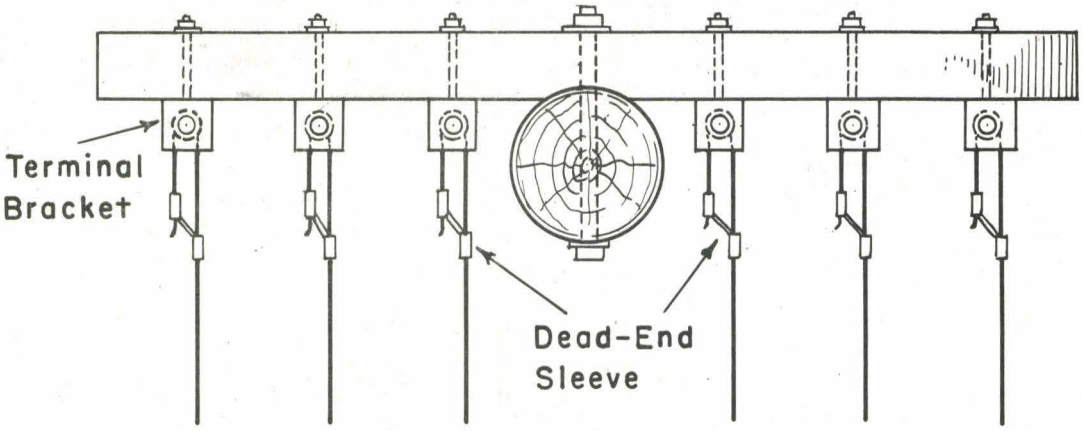

Machine bolt ½" x 4½"
Vertical Brace Galvanized angle Iron 1¾ x 1¾ x ¼" - 30 5/8
Vertical Brace Offset
Crossarm Offset
24"
Machine bolt ½" x 4½"
Step
EXTENSION ARMS (ALLEY)
Diagonal Brace - Galvanized Angle Iron 2" x 2" x 3/16" - 83"
½" x 4½" Lag screw

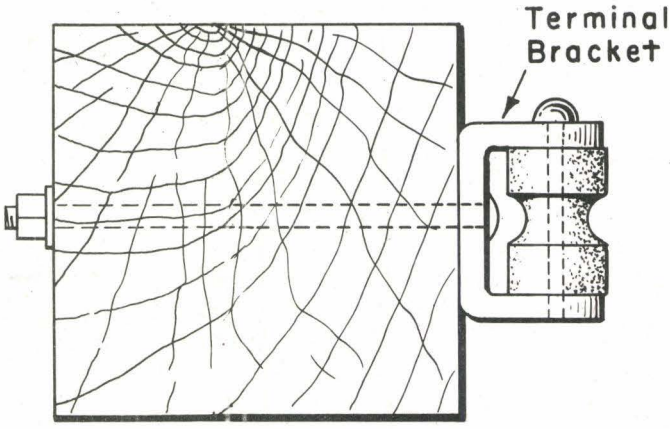
(c) If more than one extension arm is being added to a pole, the lower one should be installed first and the vertical brace attached to this extension arm at the same time that the extension brace is attached.

(d) After attachments have been installed, all bolts should be tightened securely and diagonal brace attached to the pole with a 1/2" x 4-1/2" lag screw.

Terminal Arm

The dimensions of a standard terminal arm are 4 1/4" x 4 1/2" x 6'. This shorter but heavier arm eliminates the necessity of double arms or back trusses for terminations. It is attached on the opposite side of the pole from the last span and is braced with 30" braces. Terminal brackets and insulators are used exclusively. This arm will be used at all deadends and reverse-arm construction.





DEAD END OR TERMINAL POLE SHOWING TERMINAL BRACKET INSTALLATION

102. Arms, Reverse (Buck)

Reverse arms are used in side leads where it is not possible to branch off on two poles and at right angle corners. Where the turn cannot be made on two or more poles. Reverse arms are difficult to attach and wire and should not be used at any point if it is possible and feasible to avoid them. They are a source of unusual trouble, even when well constructed.

A new reverse arm was developed in 1946. This arm 4 1/4" x 4 1/2" x 6' is heavier and shorter than the standard ten pin arm. The insulator spacing is the same for the pole pairs but all other spacing is six inches. These new arms also provide for open wire connections by a combination of pieces of line wire and compression type sleeves. It has many advantages over the old type, one of which is the open wire feature and another is the ease with which a lineman can reach all connections. It is more rugged and being shorter is subjected to less end strain.

(a) When attaching reverse (Buck) arms:

(1) Bore hole in pole 6" under the hole for the top arm but at a point to secure the desired angle.

(2) Install both arms, the top first, as outlined under "Arm, Cross" except that braces are not attached until after both arms have been bolted to the pole.

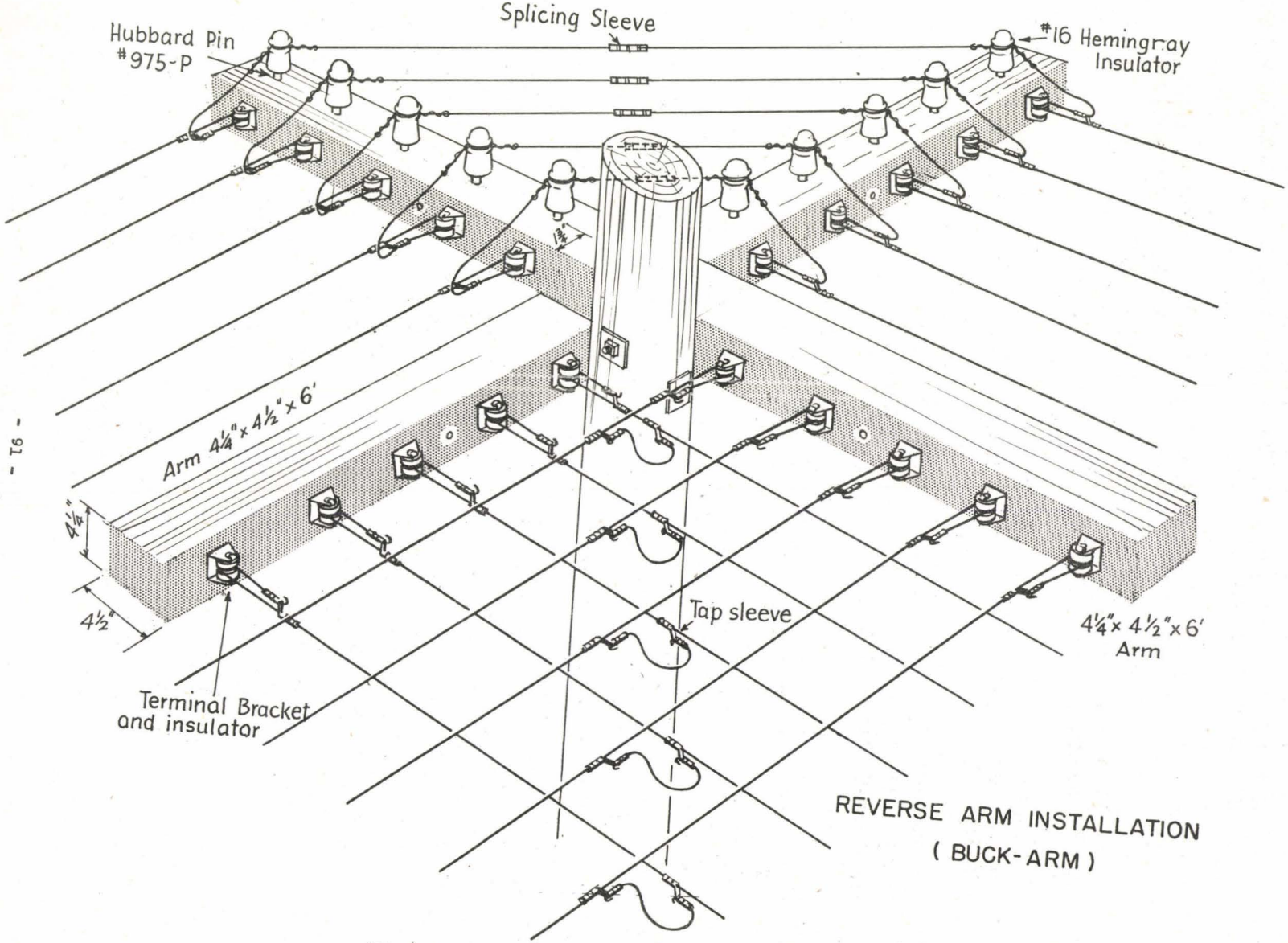
(3) After braces are attached to both arms and pole, tighten all nuts securely.

Wires should be placed on a reverse arm in the following order:

(a) Place the outer wires on each arm first. After all four outer wires have been attached to the terminal bracket insulators, they should be pulled to the proper slack leaving a "pig tail" on each wire of at least 40" in length. After the deadend sleeves have been "squeezed" the remaining wires should be attached and pulled up, all wires having a minimum 40" "pig tail" before squeezing the deadend sleeves.

(b) Lineman will find it more convenient to pull up the wires first on the sides of the crossarms opposite from the pole. (See drawing, page 91)

(c) Tie the "pig tails" to the proper insulator and connect them with a splicing sleeve.



REVERSE ARM INSTALLATION
(BUCK-ARM)

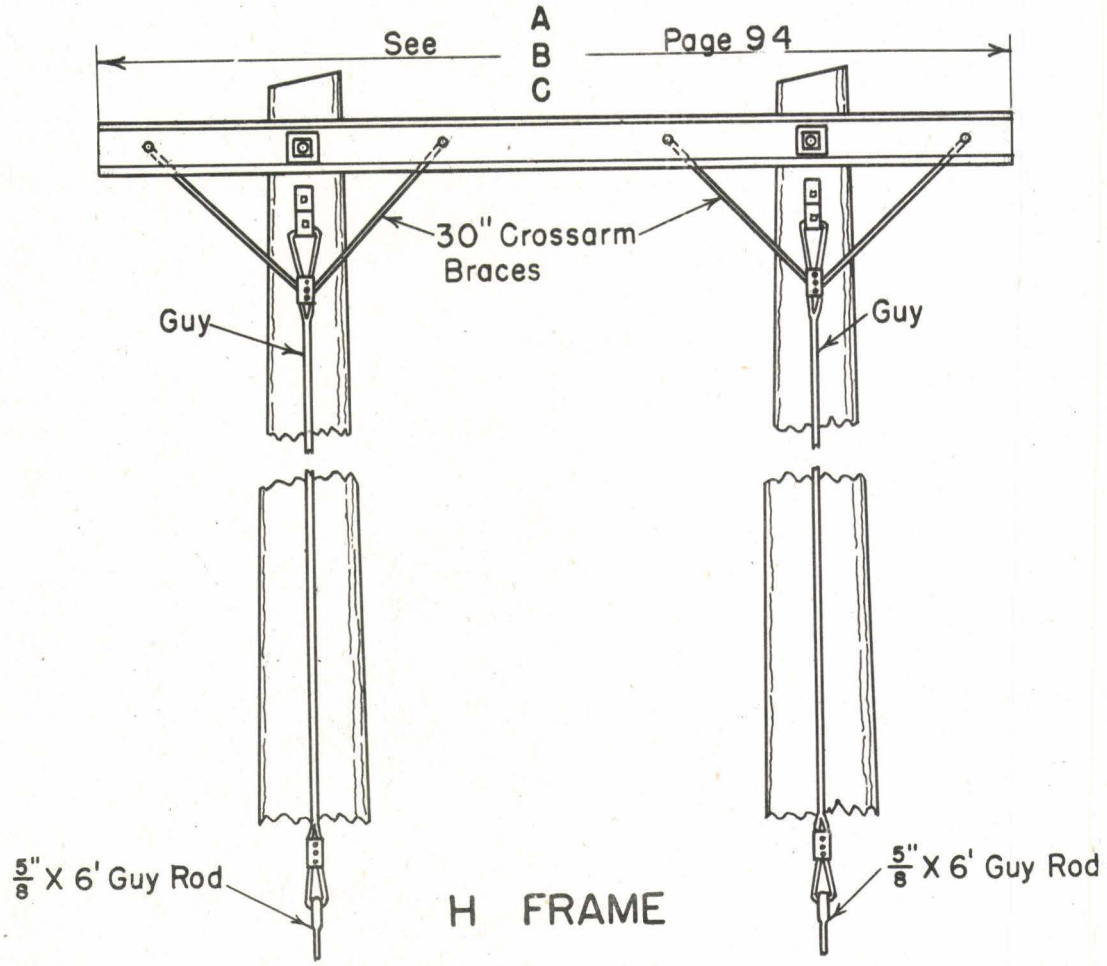
103. H-Fixtures

Use H-Fixtures for long spans, having in excess of four wires, for marshy soils where difficulty would be experienced properly guying a single pole and at points where a single pole would need to be storm guyed but where side guys are not possible.

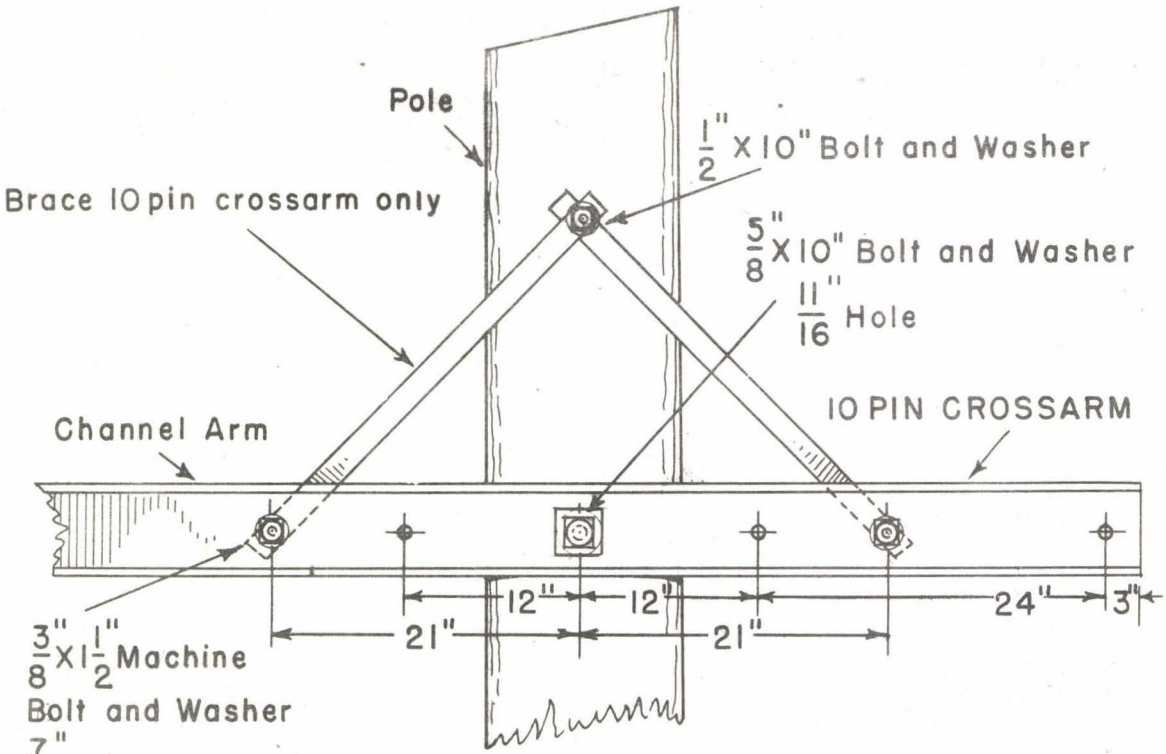
H-Fixtures should be completely assembled on the ground where the terrain will permit use of motorized equipment in raising the structure. Any motor equipment so used must have ample power and traction. Use hand methods pages 72-74 where motor equipment cannot be used.

The arm or arms should be attached after the poles have been erected, backfilled and tamped. After attaching arm tighten bolts, attach and pull up guys and retamp.

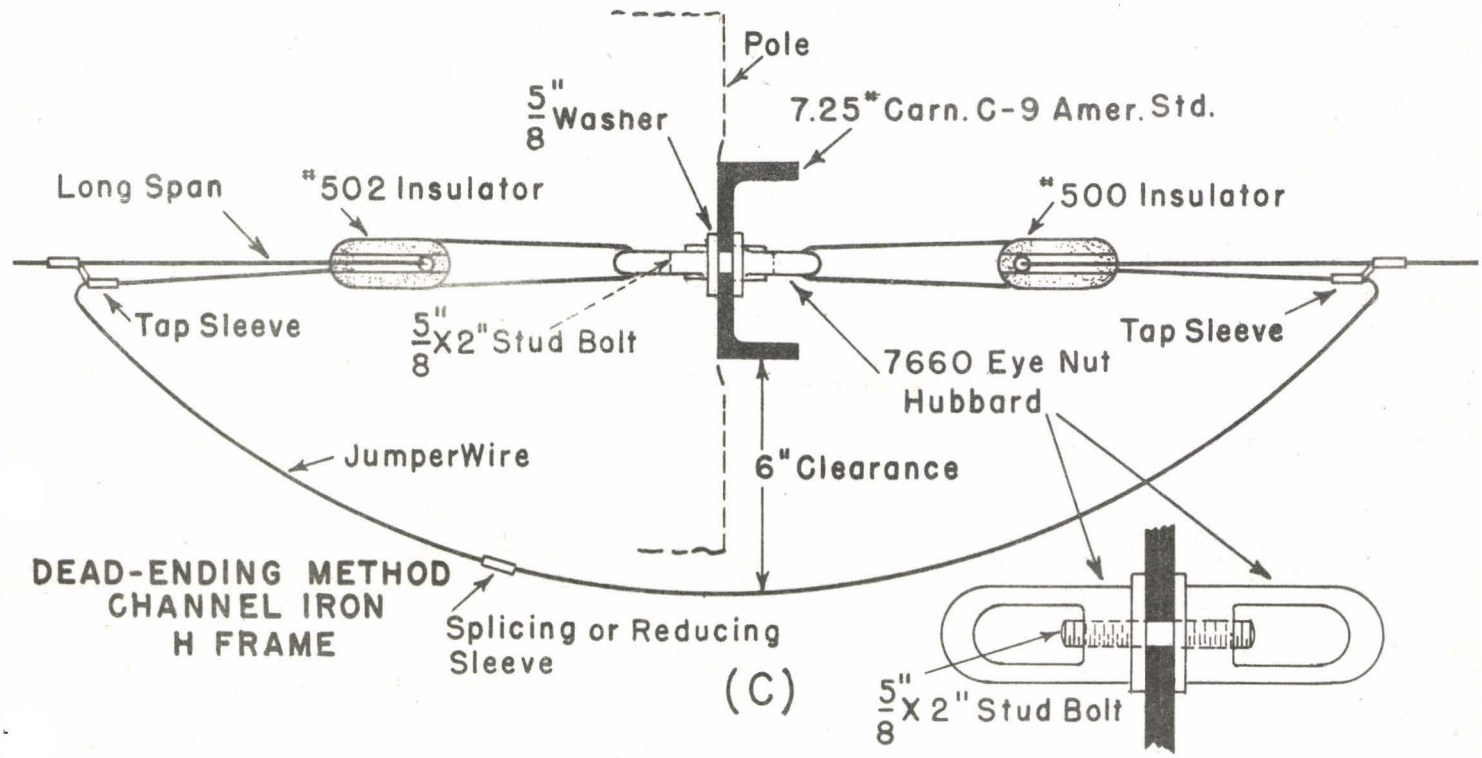
Leave 30" "pigtail" on each dead-end for use as a jumper wire under the arm. Connect wires with splicing or reducing sleeves. See (c) page 93.



H FRAME



CHANNEL ARM
(H-Frame)



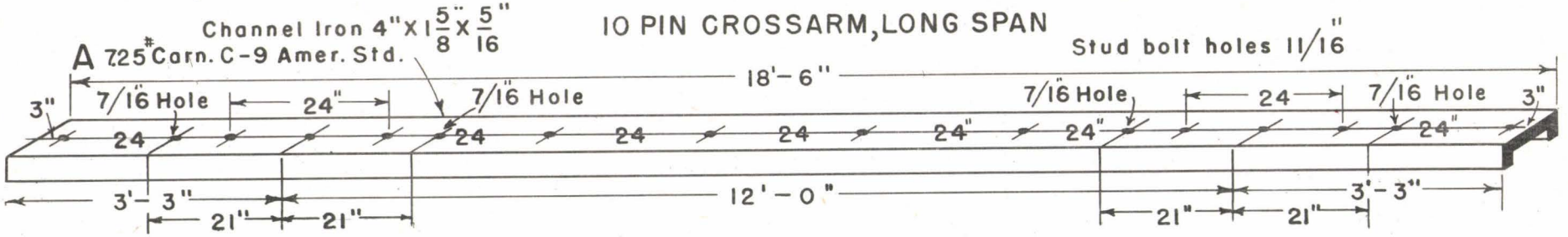
DEAD-ENDING METHOD
CHANNEL IRON
H FRAME

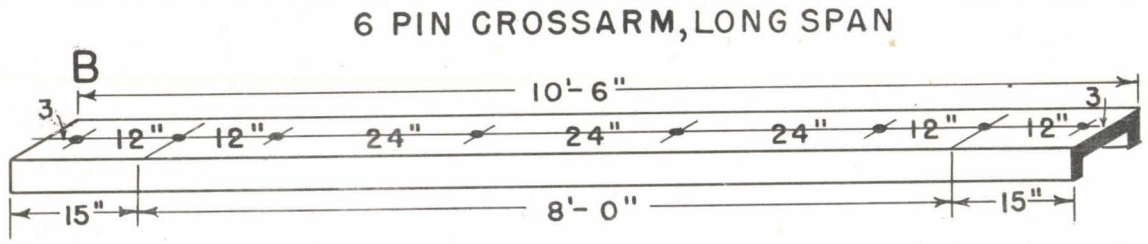
(C)

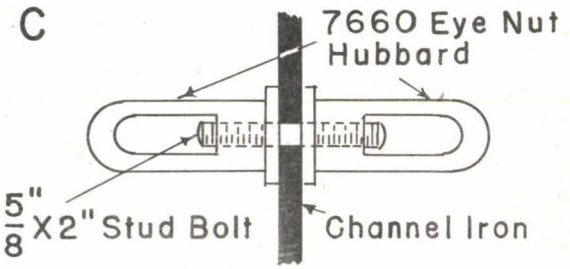
Table for Minimum Spacing, Number and Size of Wires And Type of Construction for Long-Spans, Pole Line

Length of Span (ft.)	Kind and Size Of Wire	Type of Construction	Type of Dead-end Fixture	Number of Wires	Minimum Spacing
300 - 500	*#10cc steel	Vertical 1 pole	See A page 104	2 - 4	22"
500 - 1000	# 8cc steel	Vertical 1 pole	See A page 104	2 - 4	22"
Over 1000	# 6cc steel	Vertical 1 pole	See A page 104	2 - 4	28"
300 - 500	#10cc steel	Std. double Crossarm	See pages 93-94	6 - 10	12"
500 - 1000	# 8cc steel	H-Frame Ch. Iron	See pages 93-94	6 - 10	24"
Over 1000	# 6cc steel	H-Frame Ch. Iron	See pages 93-94	6 - 10	24"

*Copper-covered steel wire. For heavy loading areas increase wire size to 4 over 1000 feet.



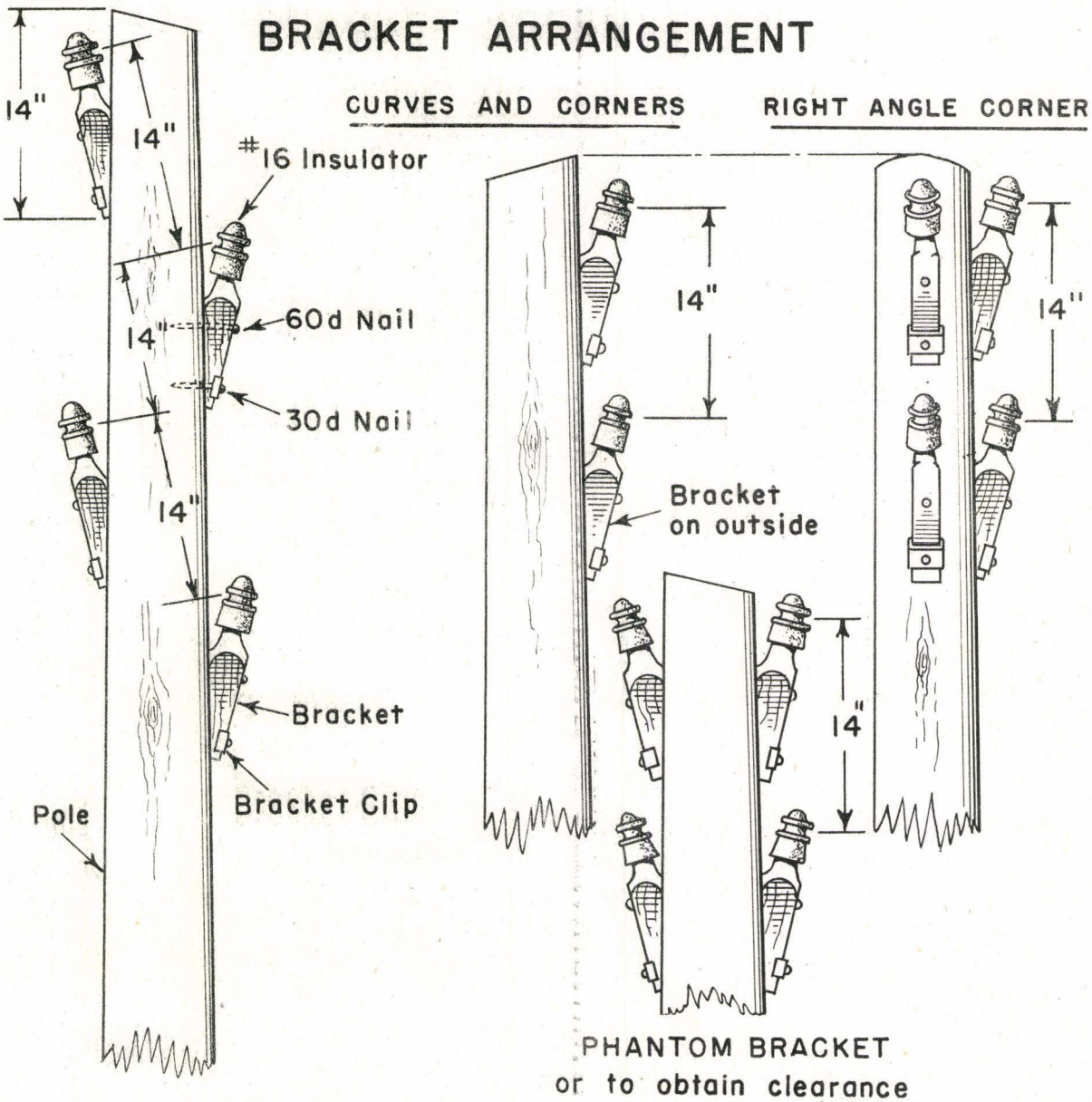




104. Brackets

One or two circuits will be supported by staggered bracket construction separated by a diagonal distance of 14 inches, except on curves and corners, where all brackets will be placed 14 inches apart on the side of the pole opposite the direction of pull so the pull of the line wire will be toward the pole. On angles and corners having a pull of 30 feet or more, double-bracket construction shall be used. Use a terminal bracket with 1/2-inch bolt through the pole for dead ends.

Where consideration is to be given to phanton transposition, the brackets on the second circuit shall be opposite those of the first circuit, at least on the adjacent pole each



side of the transposition pole. This is necessary regardless of pull. Where the pull on brackets is away from the pole, the perforated hanger strap should be used. (See diagrams page 97.

(a) Follow the procedure below in attaching brackets:

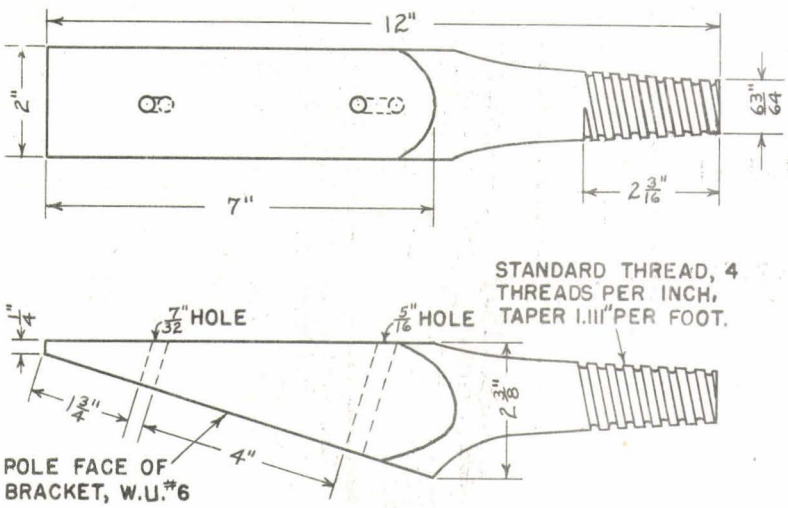
(1) Wood brackets should be installed where possible previous to the erection of the pole as indicated in the illustration on page 95.

(2) Where another line is to be added to a pole after erection, the brackets should be installed under those in place in accordance with illustration on page 95.

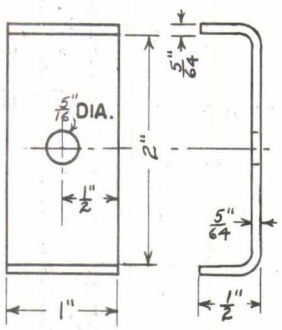
(3) Where brackets have not been used previously on an erected pole, care should be exercised to place the brackets on the pole to secure the maximum clearance between pole and wire.

(4) Bracket clips should be used at the lower end of the bracket under the bottom nail only.

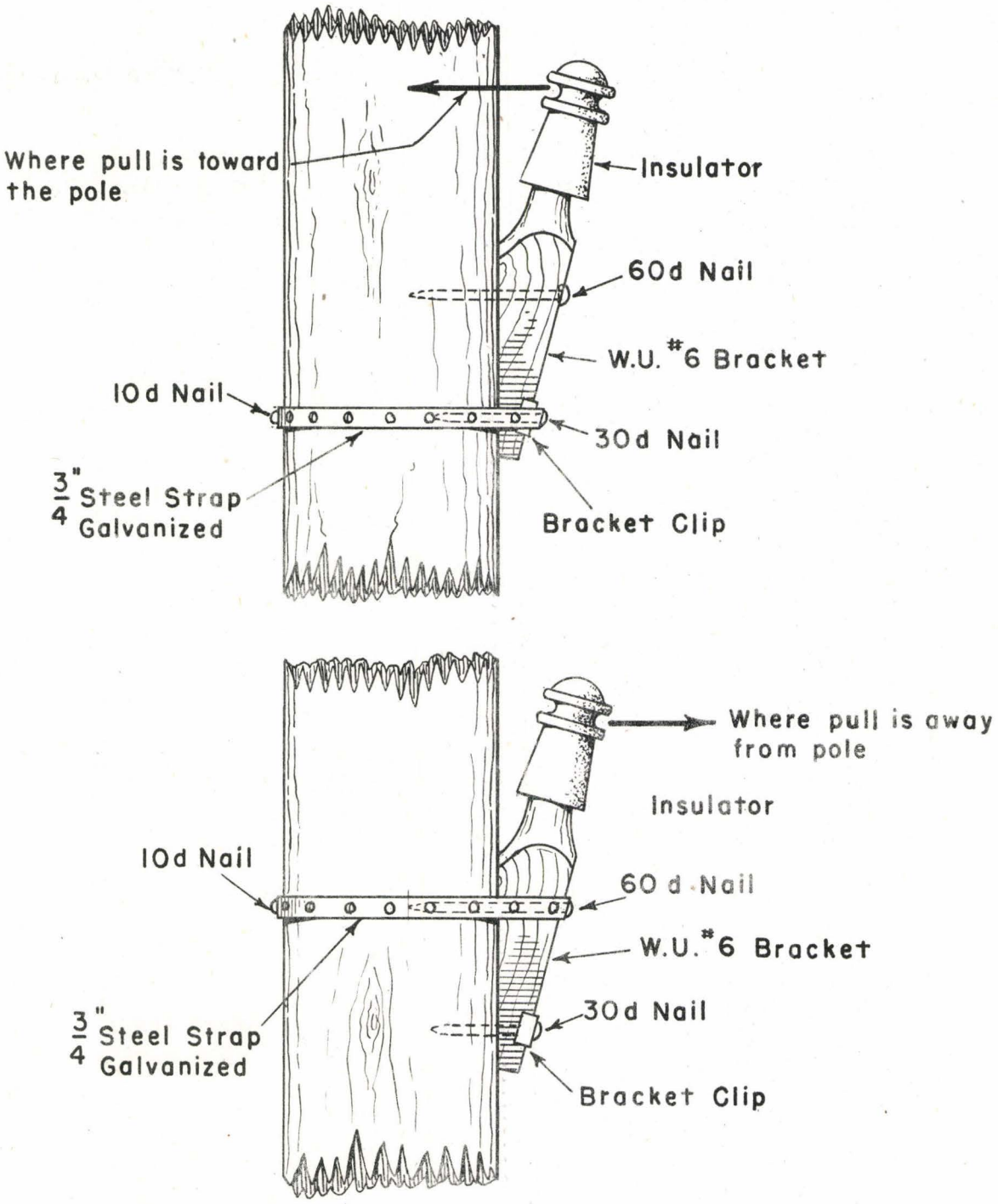
(5) When erecting poles with brackets along road sides, the top bracket should be on the roadside, except at transposition points or corner poles.



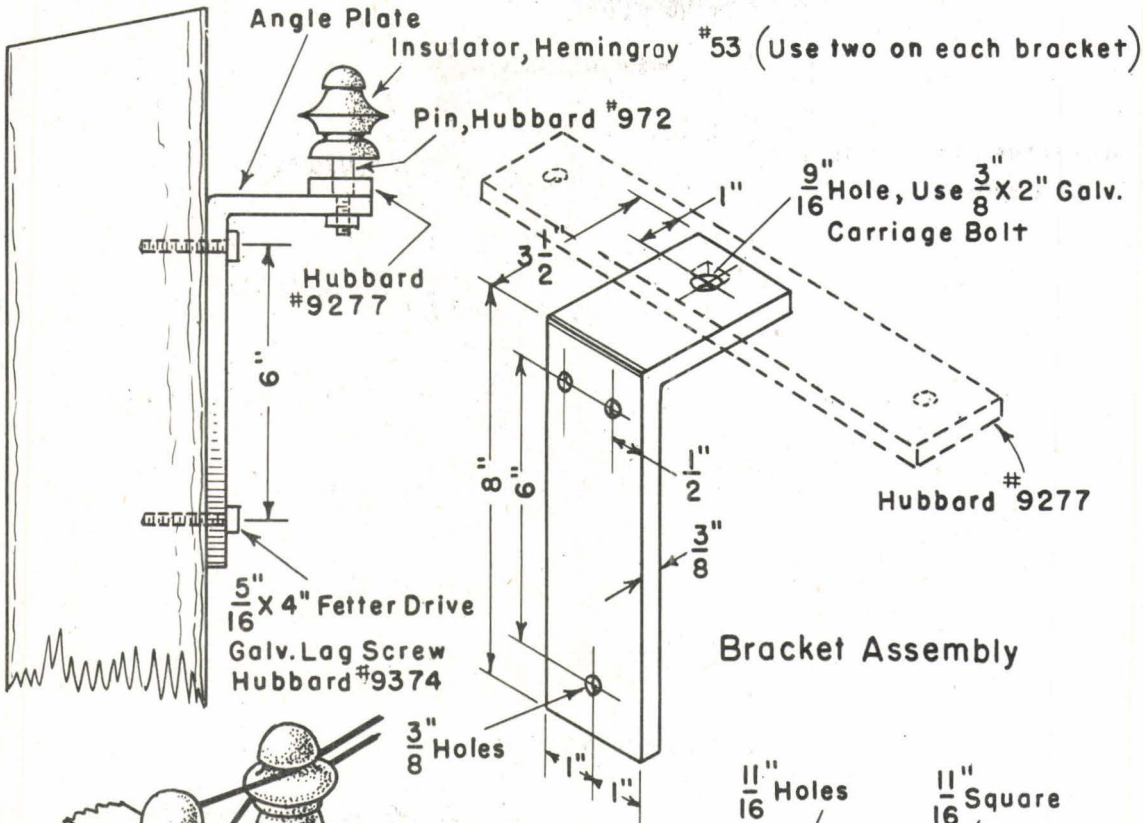
STANDARD WOOD BRACKET



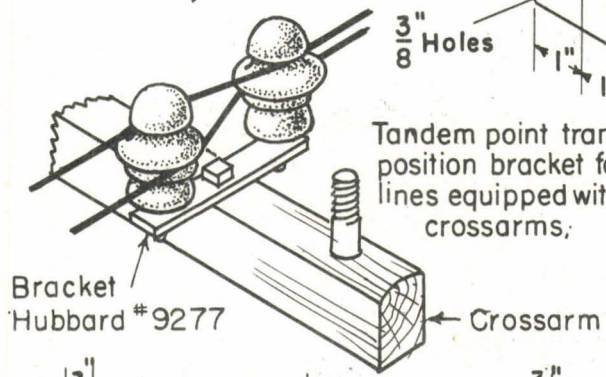
BRACKET CLIP

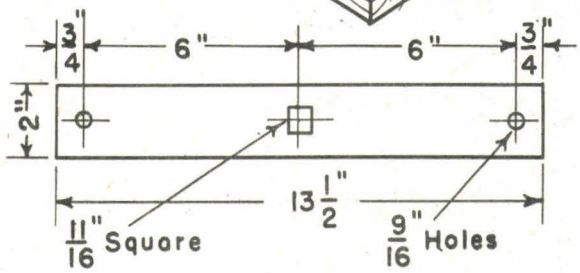


BRACKET INSTALLATION WHERE PULL IS TOWARD OR AWAY FROM POLE

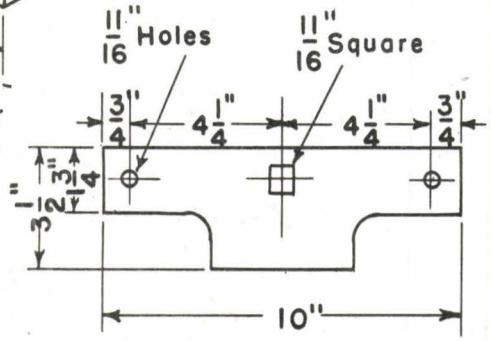


Bracket Assembly



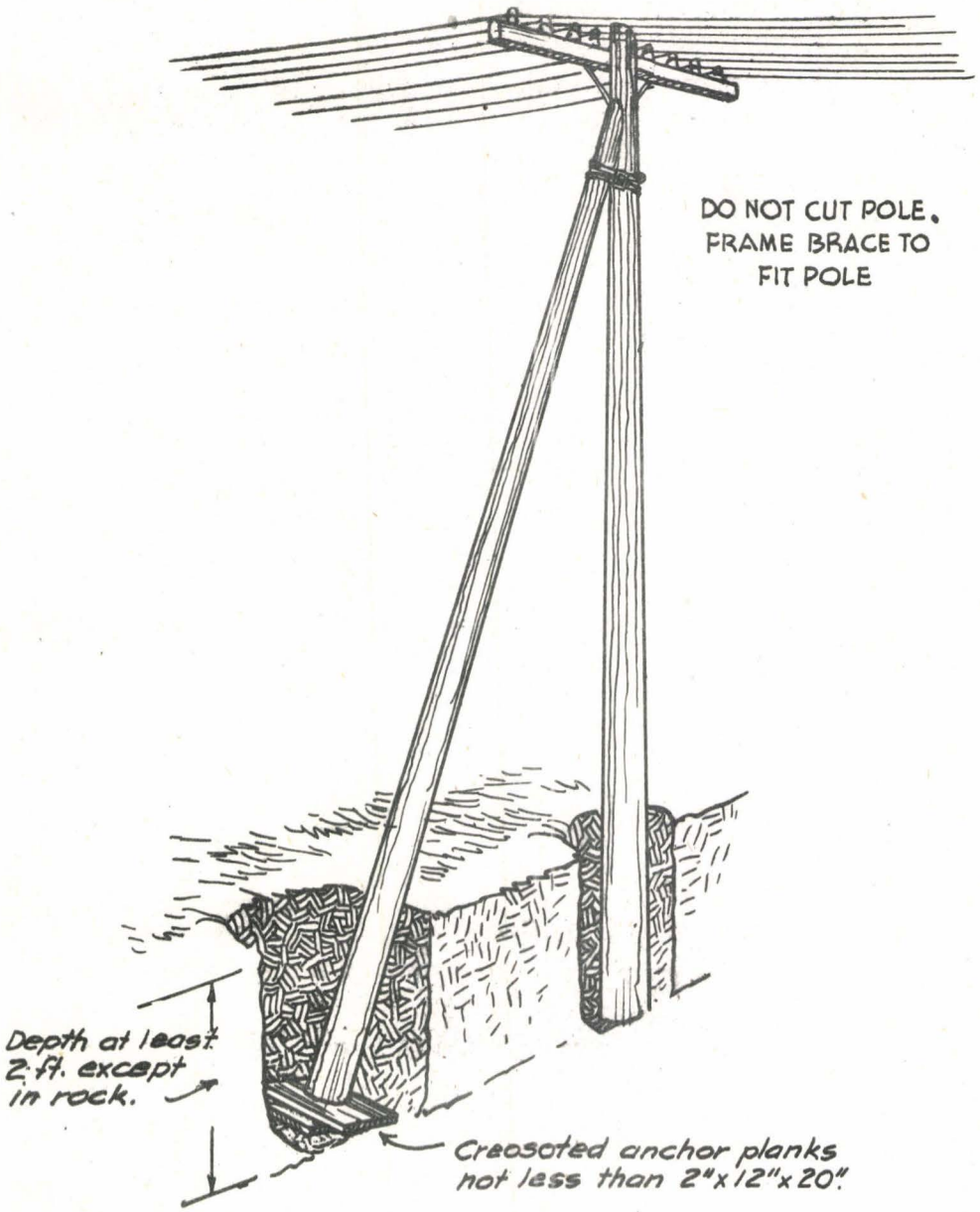


B-Tandem Transposition Bracket
Hubbard #9277



C-Tandem Transposition Bracket
Hubbard #9278

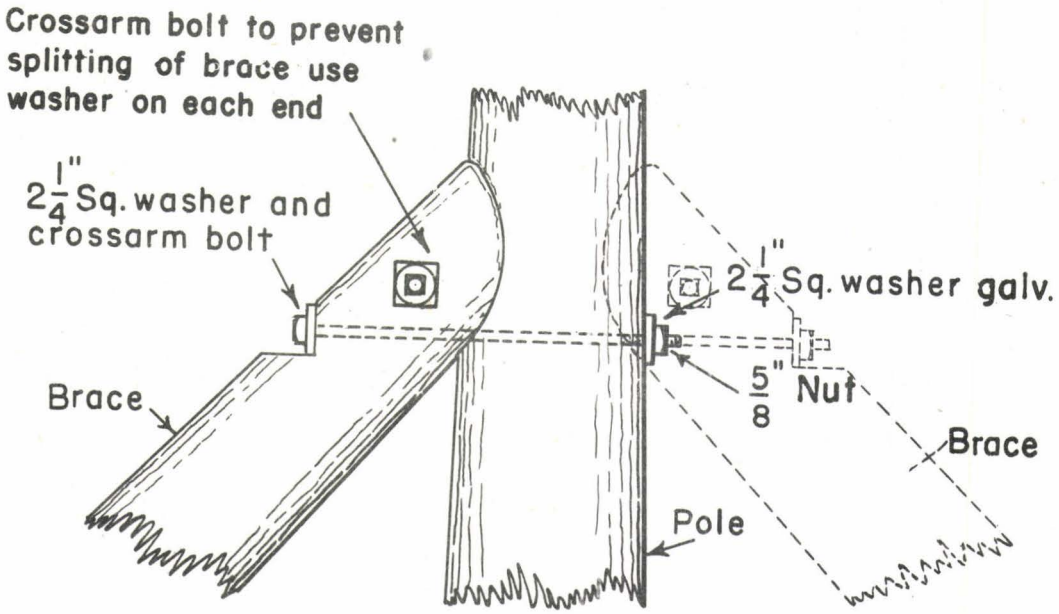
R' TRANSPOSITION BRACKET AND ANGLE PLATE



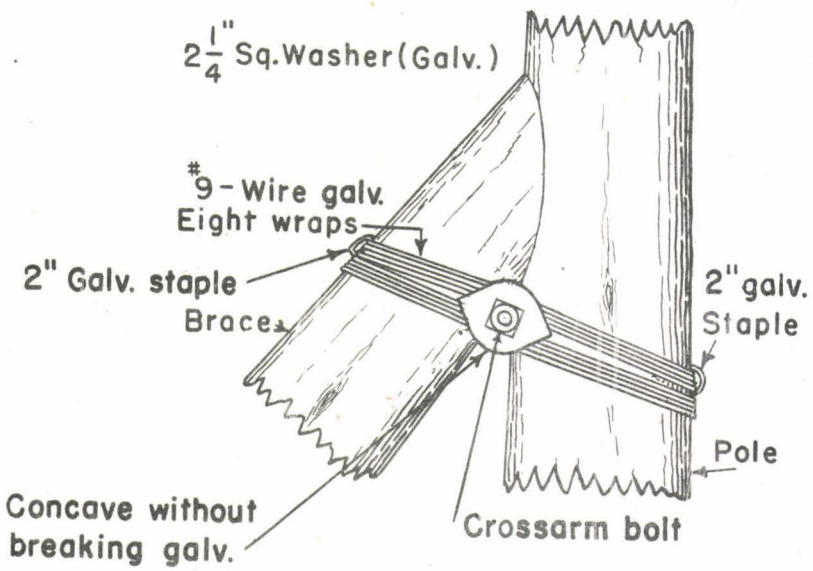
PUSH POLE BRACE

105. **Braces, Push Pole**

Push braces should be used as alternates for guy wires only where suitable locations for anchors and guys are not available. They should be of the same material as the poles which they are bracing. See page 100 for detail of attaching braces.

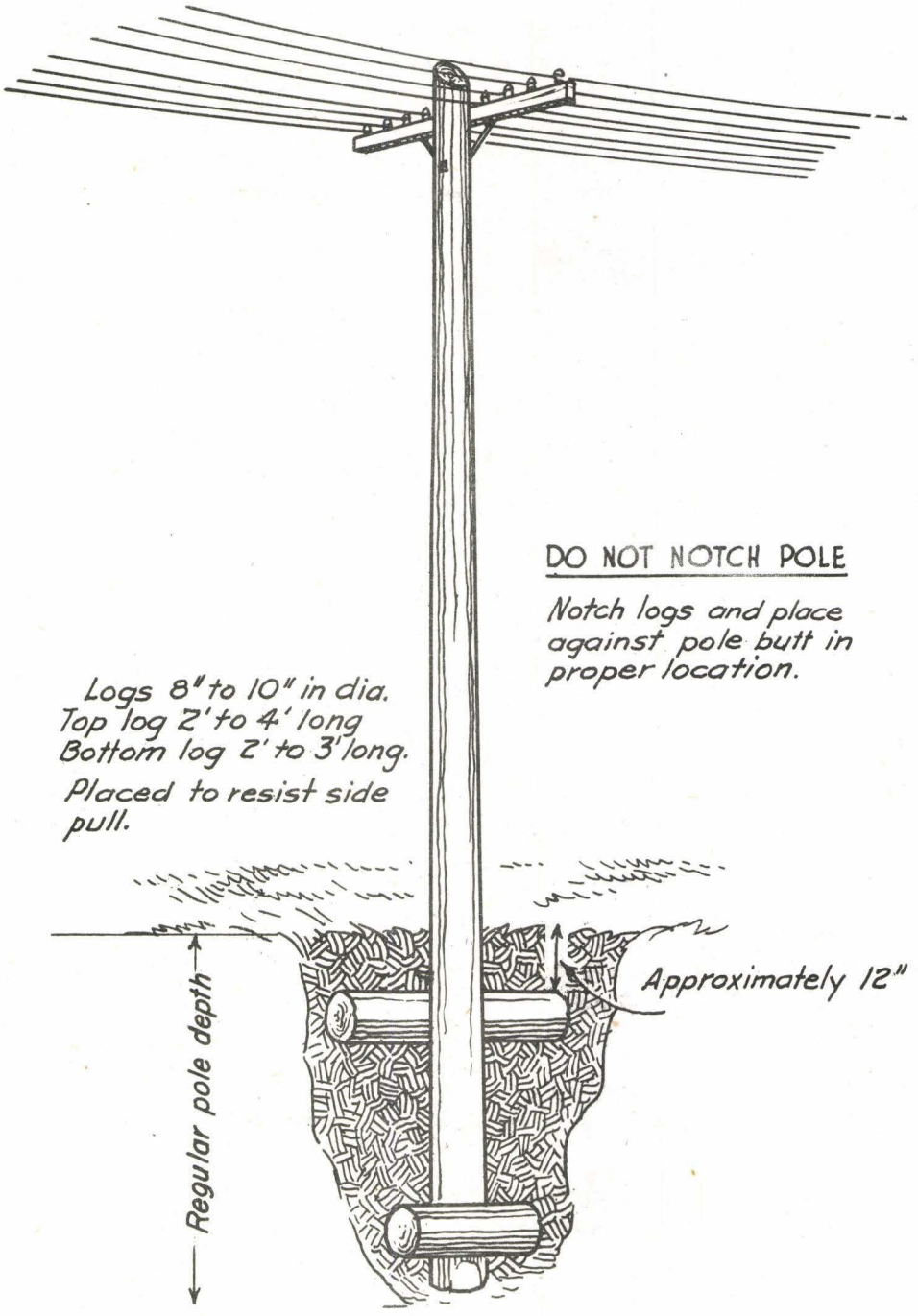

Crossarm bolt to prevent splitting of brace use washer on each end
2 1/4" Sq. washer and crossarm bolt
2 1/4" Sq. washer galv.
5/8" Nut
Brace
Brace
Pole

BOLT METHOD (PREFERED)



WIRE WRAP METHOD (ALTERNATE)

ATTACHING METHOD
(PUSH POLE BRACE)


DO NOT NOTCH POLE
Notch logs and place against pole butt in proper location.
Logs 8" to 10" in dia.
Top log 2' to 4' long
Bottom log 2' to 3' long.
Placed to resist side pull.
Approximately 12"
Regular pole depth

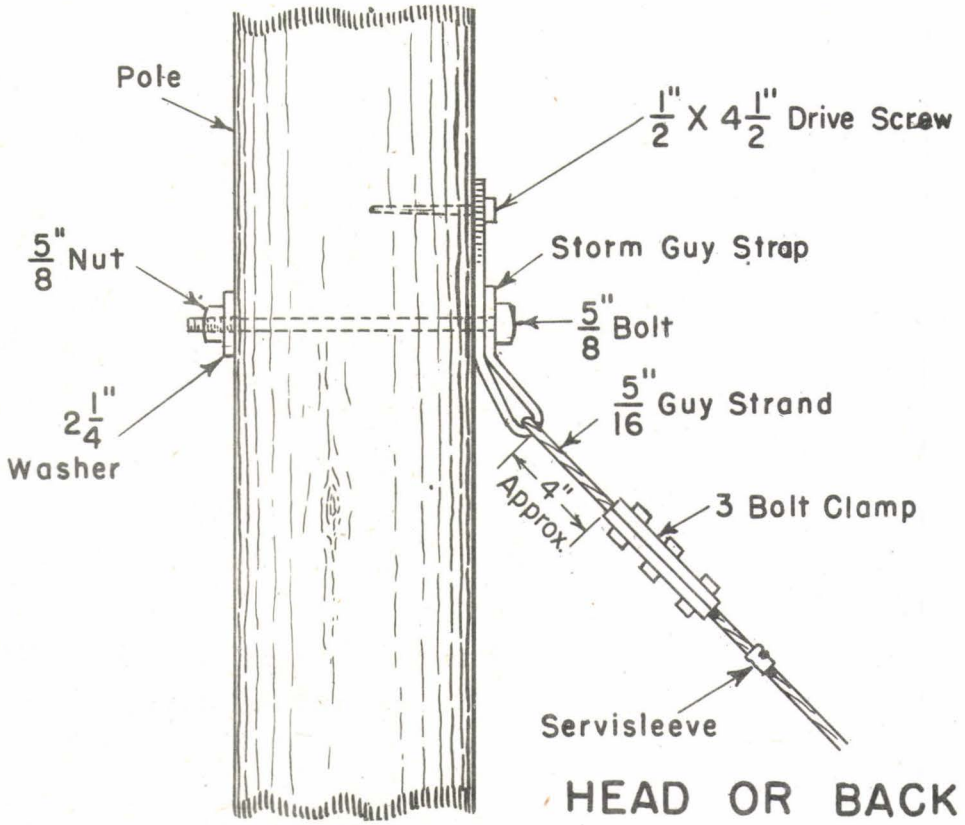
For use in soft earth at small angle points only - guying usually neccessary where angle exceeds 5° on such ground

POLE BRACING (GROUND)

106. Guying

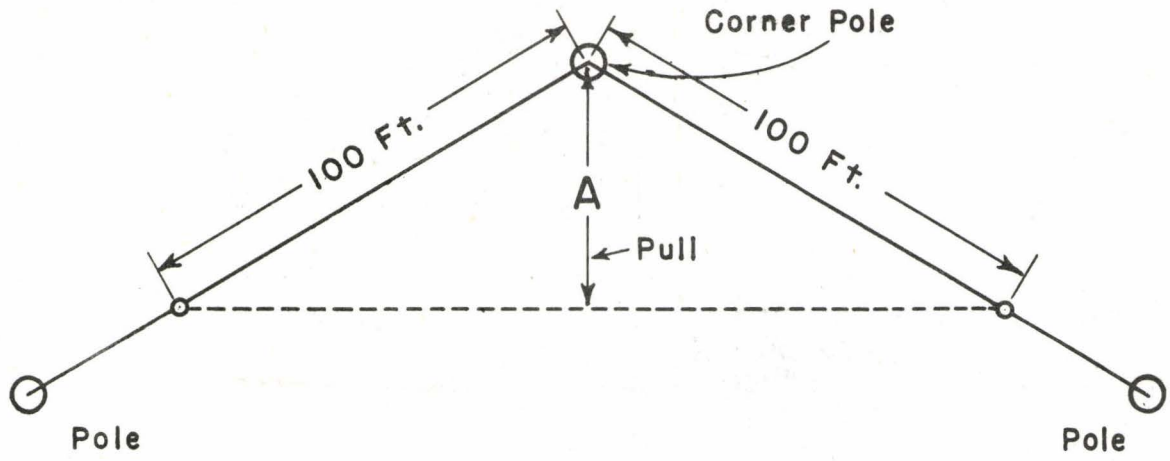
Correct guying is one of the most important factors in the construction of open wire or cable lines. Guys take up the unbalanced loads at corners and dead-ends, thus preventing poles from overturning or pulling out of line with the resulting consequence of too much slack in line wires. Hence, all guys and braces should be installed and required rake obtained prior to the stringing of line wires or messenger. The top of poles to which guys are to be attached should be set about 6 inches out of line in the opposite direction from the guy wire. Then, with tension on the guy wire, pull the top out of line toward the guy 6 inches. After line wires are attached and construction has settled, the top of the guyed pole will come into line with other poles. Some modification of this method may be necessary in rock or rocky and firm soil. Blocks shall be used for pulling up slack in guys.

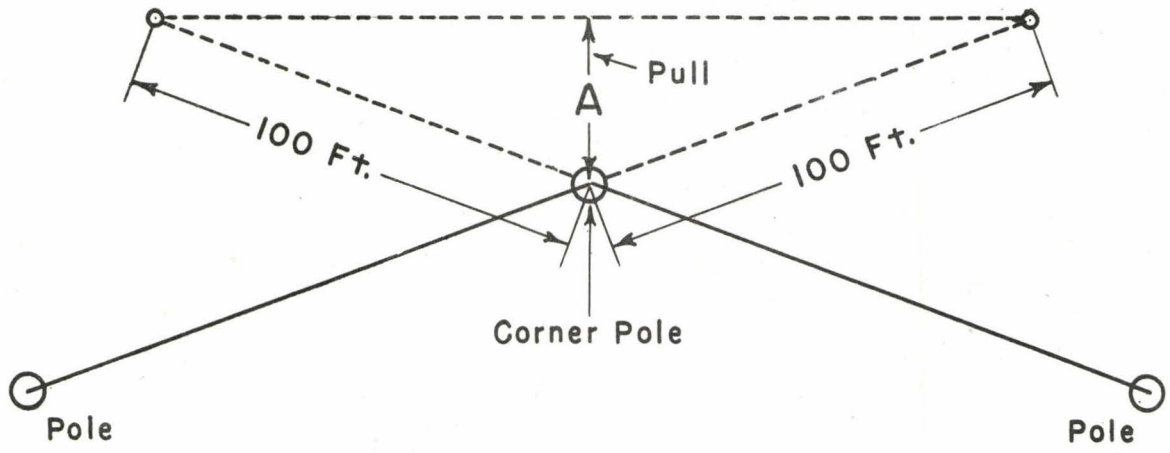
Where insulators are used in guy wires, they will be placed 8 to 10 feet from the ground or 6 to 8 feet from the pole. There follows eight illustrations on guying each one of which should be carefully studied before planning of guying is attempted.

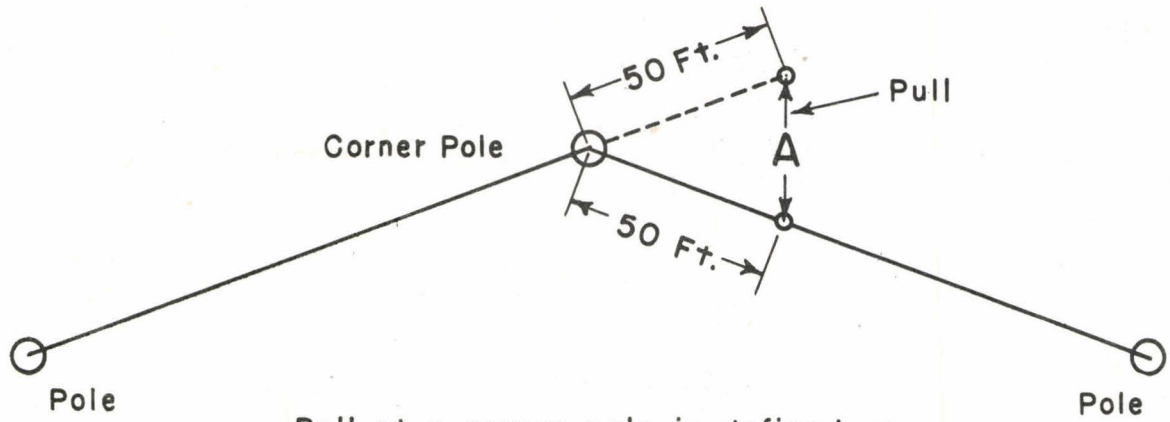


HEAD OR BACK GUY

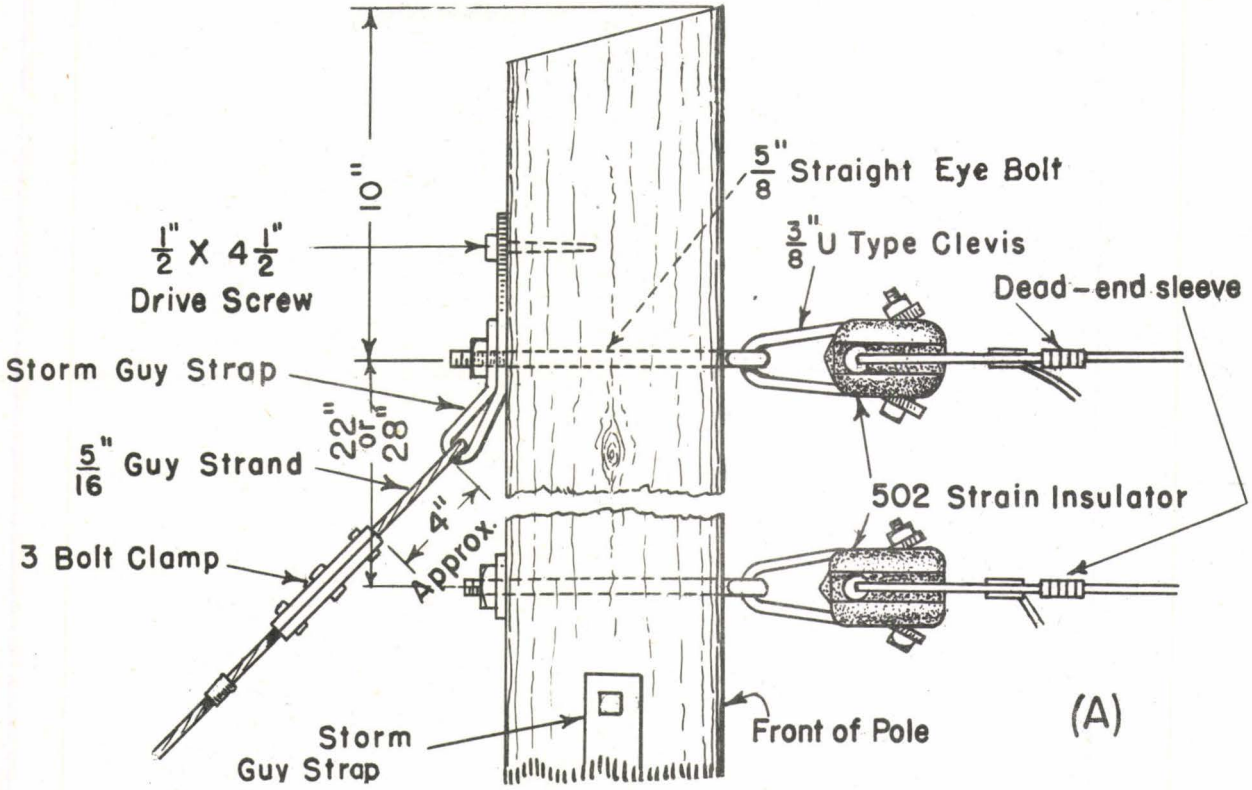
PULL-CORNER POLE

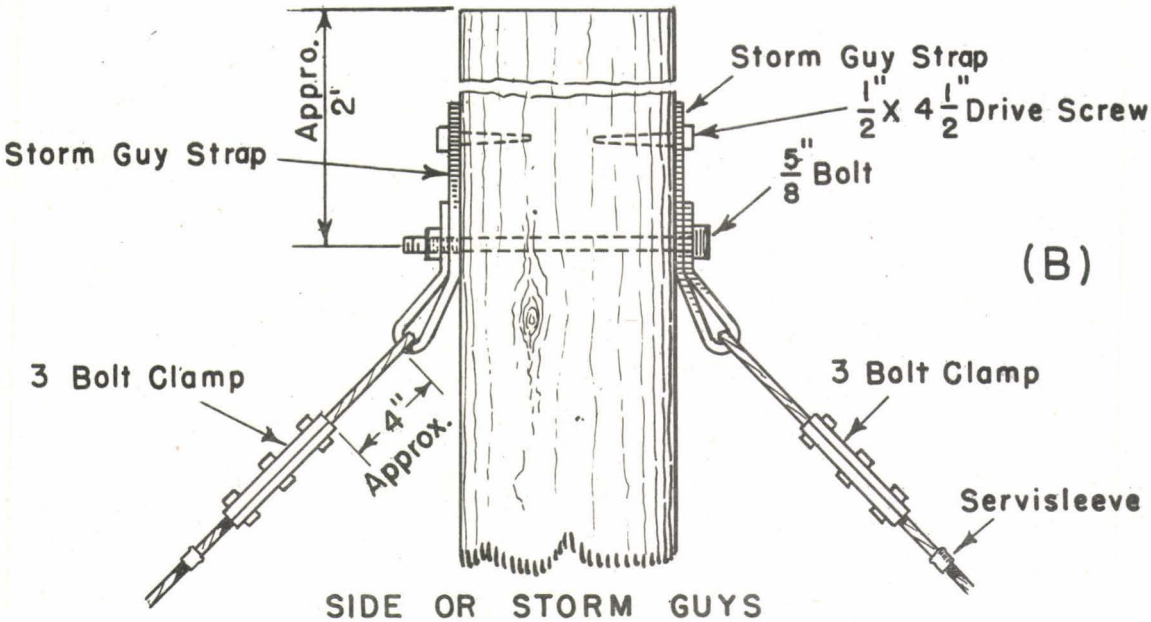






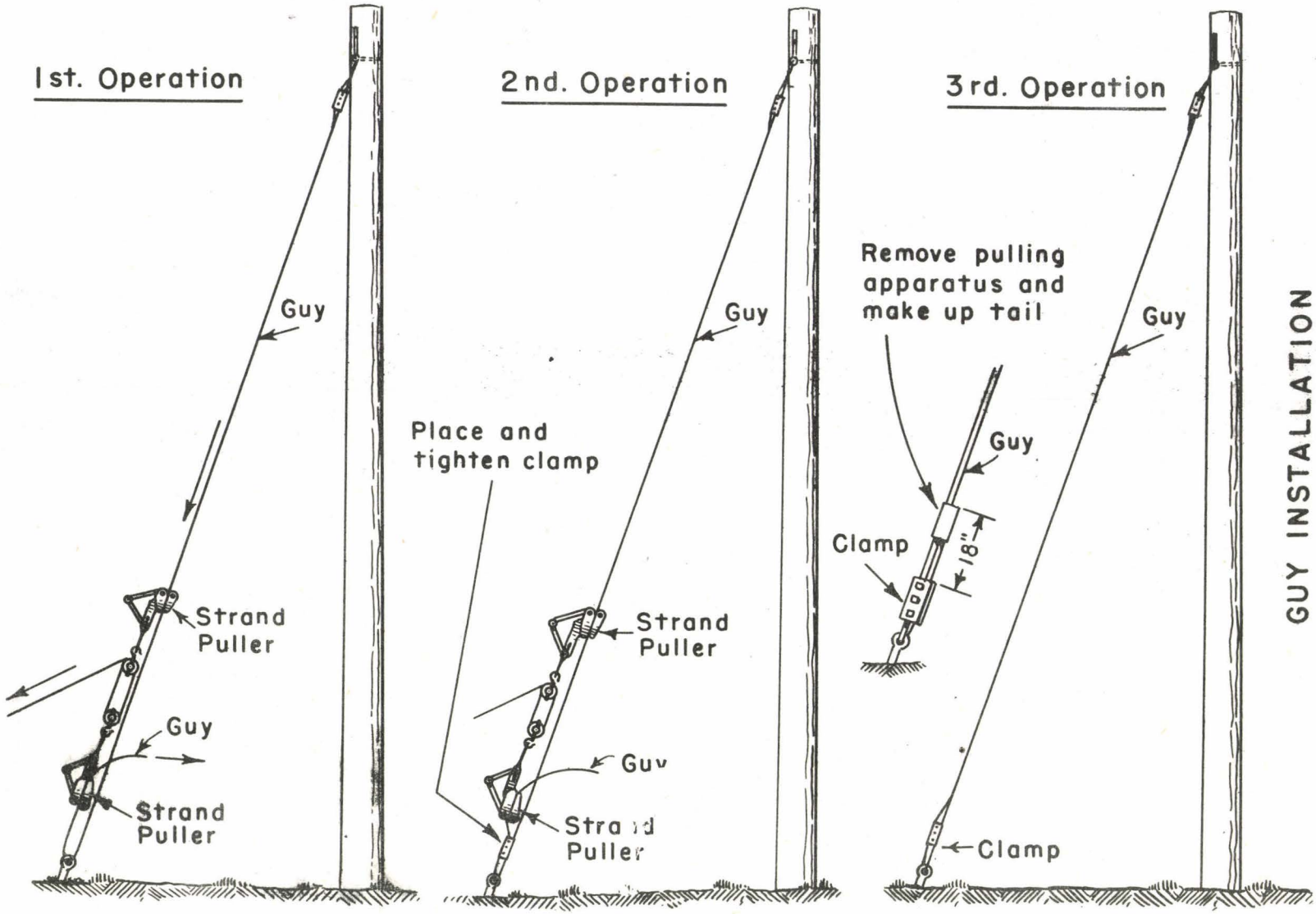
Pull at a corner pole is defined as the distance in feet measured as illustrated above





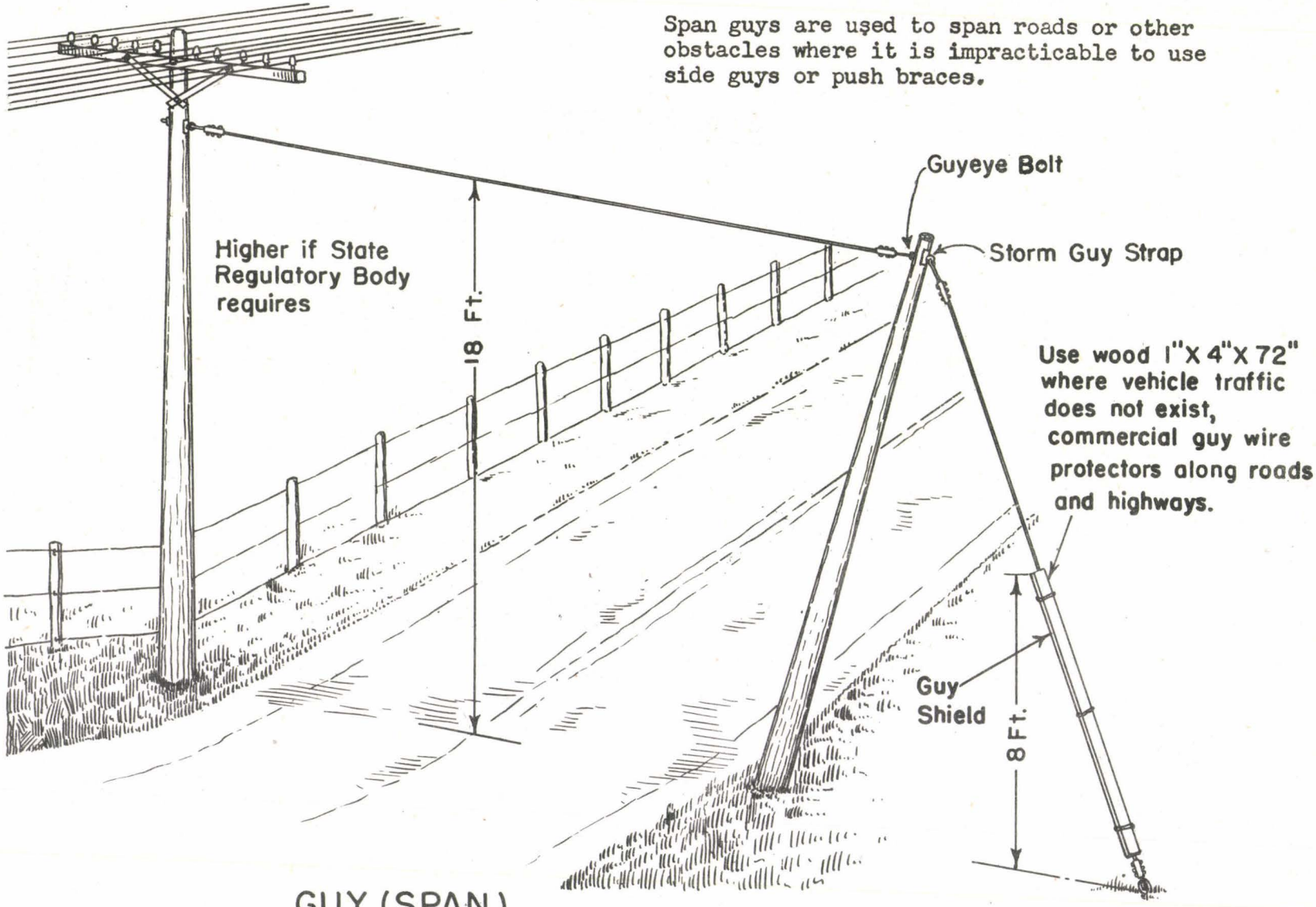
SIDE OR STORM GUYS

ATTACHING INSULATORS AND GUYS
TO DEAD END POLES, FOR LONG SPANS.

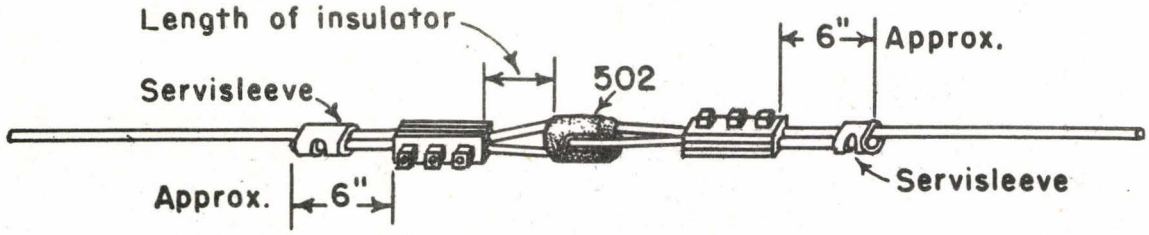


GUY INSTALLATION
(Method)

Span guys are used to span roads or other obstacles where it is impracticable to use side guys or push braces.

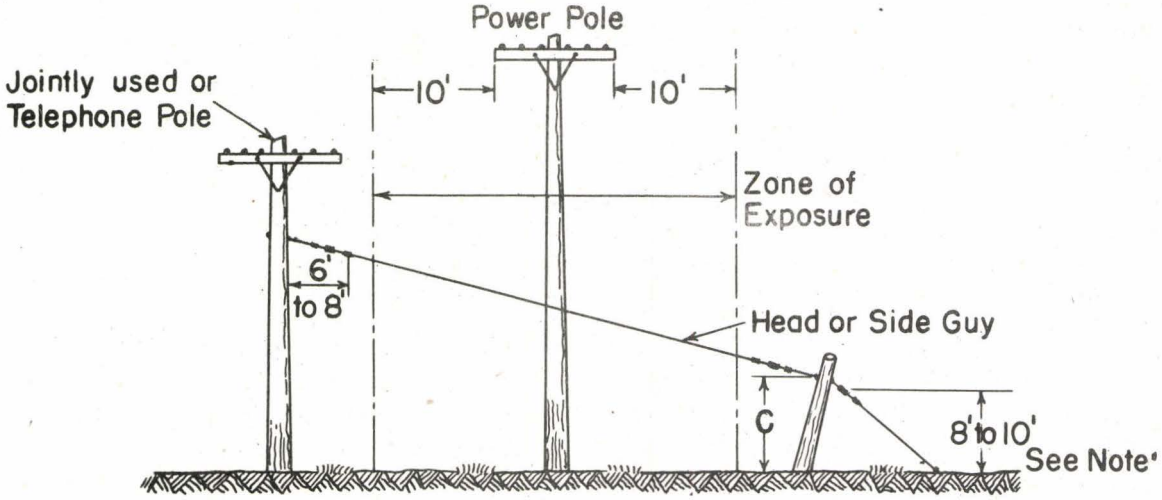

Guyeye Bolt
Storm Guy Strap
Higher if State Regulatory Body requires
18 Ft.
Use wood 1"X 4"X 72" where vehicle traffic does not exist, commercial guy wire protectors along roads and highways.
Guy Shield
8 Ft.

GUY (SPAN)

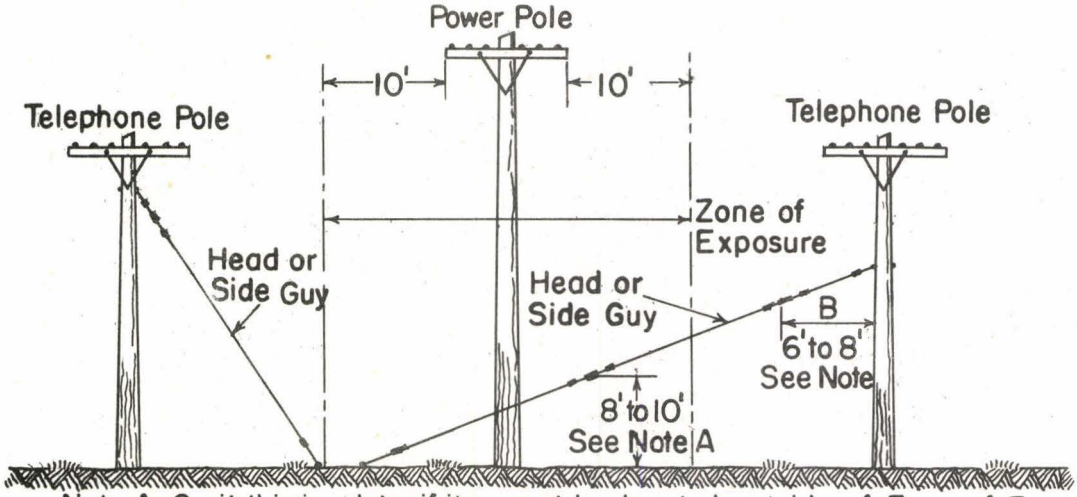


6,000 and 10,000 LB. STRAND

STRAIN INSULATOR MAKE UP



Note: If C is less than 8' place insulator near pole but outside zone of exposure.



Note A, Omit this insulator if it cannot be located outside of Zone of Exposure.

Note B, This insulator to be placed only when insulator at A is omitted.

GUY INSULATORS, REQUIREMENTS

107. Guy Shields - (Guards)

Guy shields are for the purpose of warning people and animals of an existing hazard and protecting the guy itself, and are required any place where there may be foot, vehicular, or horse travel such as along public roadways or within closed fields when requested by landowners. Wood shields 1"x4"x8' painted white are satisfactory only for foot traffic or within closed fields when requested by landowners. For guy wire which may be contacted, through accident or otherwise, by vehicles, where deterioration of wood is a problem, or where required by law the slide-on type galvanized steel guy wire protector should be used.

108. Pole Dating

Marking the pole with the date of installation is suggested as a means of determining the life of poles without the necessity of keeping voluminous records. Special nails are available with year numerals stamped upon the head; these are adequate and quite inexpensive.

109. Pole Painting

There are occasional installations where it is desirable to paint or stain poles to effect a better appearance and to make them blend into landscape or building arrangement, or as warning to vehicles. Painting of creosote treated poles is not believed practical and for this reason only butt treated cedar should be used where painted or stained poles are desired.

110. Stepping

Standard arrangement of pole steps should be used on poles where, because of attachments, it is frequently necessary to climb the poles. Such poles as terminal poles, junction poles and test stations are examples.

Locate pole steps as shown on drawing "Cable Terminal Pole".

The following general rules should be observed:

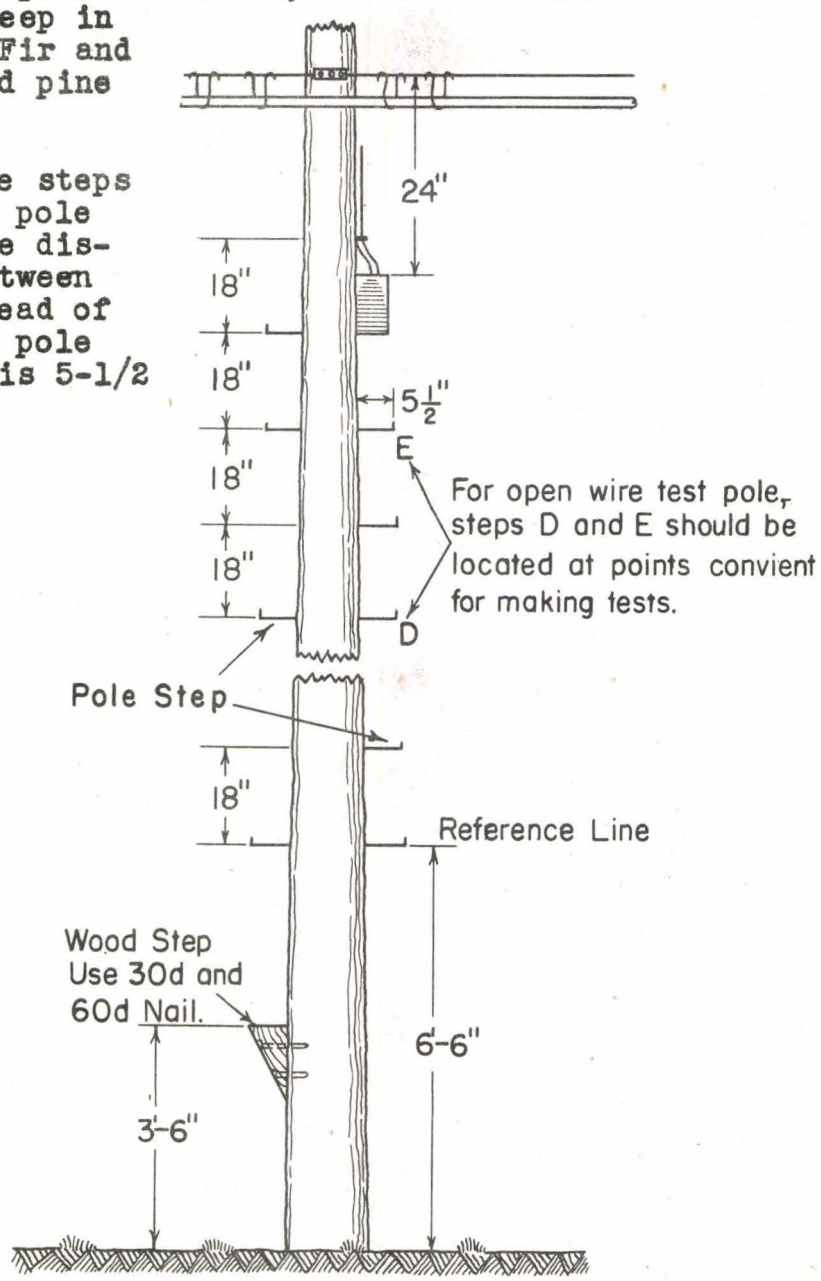
(a) The first pole step shall be wood and located 3' 6" above the ground line.

(b) Locate two iron steps opposite each other, 6' 6" above the ground line.

(c) Locate steps 18 inches apart on alternate sides of the pole until within approximately five feet of the top of the pole or at a more convenient spot; then place two steps each opposite the other. This is for convenience and safety of the workman. Then add one more step, spaced about 18" inches above the double step.

(d) Bore 3/8-inch lead holes, 2 to 3 inches deep in cedar poles. Bore 1/2-inch lead hole 3 inches deep in Douglas Fir and creosoted pine poles.

(e) Drive the steps into the pole until the distance between inside head of step and pole surface is 5-1/2 inches.

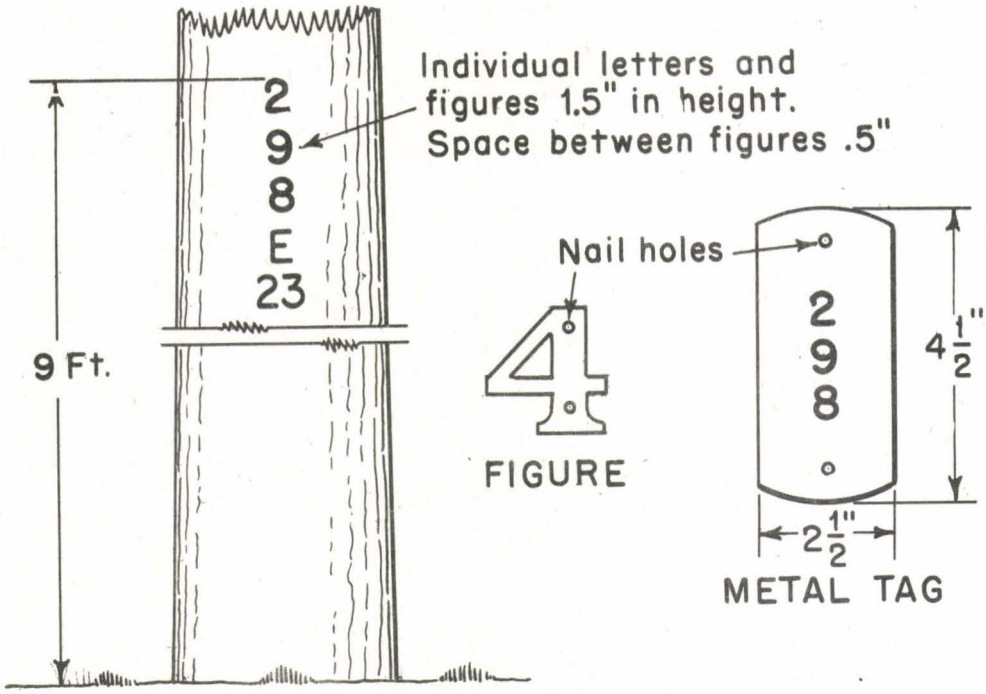


CABLE TERMINAL POLE
(STEP LOCATION)

111. Pole numbering

Due to the fact that most Regions have their own pole numbering system the method of numbering poles will be optional with Regions. Each Region should adopt its own standard. A suggested standard follows: Numbering would be accomplished by using metallic numbers or metallic tags with impressed numerals. Such numbers or tags would be large enough to be read from the roadway where lines follow along the same right-of-way. They would be placed on the pole so as to face the road. Starting at the main switching station poles shall be numbered in the direction of transposition and shall continue consecutively to the termination of the line or to the first important switching center. This point shall then be considered a new origin and the numbering again started.

Where lines branch from the main line, the branch line numbering shall start from the junction pole as the origin. In addition to pole numbers the transposition poles will be marked to correspond with the transposition occurring at that point. See Illustrations below.



NUMBERS OR TAGS TO BE ATTACHED WITH 4d GALV. NAILS

METHODS OF PLACING NUMBERS ON POLES

112. Pole Protection Grounds

Consists of a piece of wire (same as line wire) extending from the bottom of the pole to a point 4 inches above the top of the pole with a 4 inch gap left in the wire 8' above the ground level. Such conductors provide a path for charges that could otherwise shatter the pole. The introduction of the gap provides the necessary insulation from ground for linemen working on the pole.

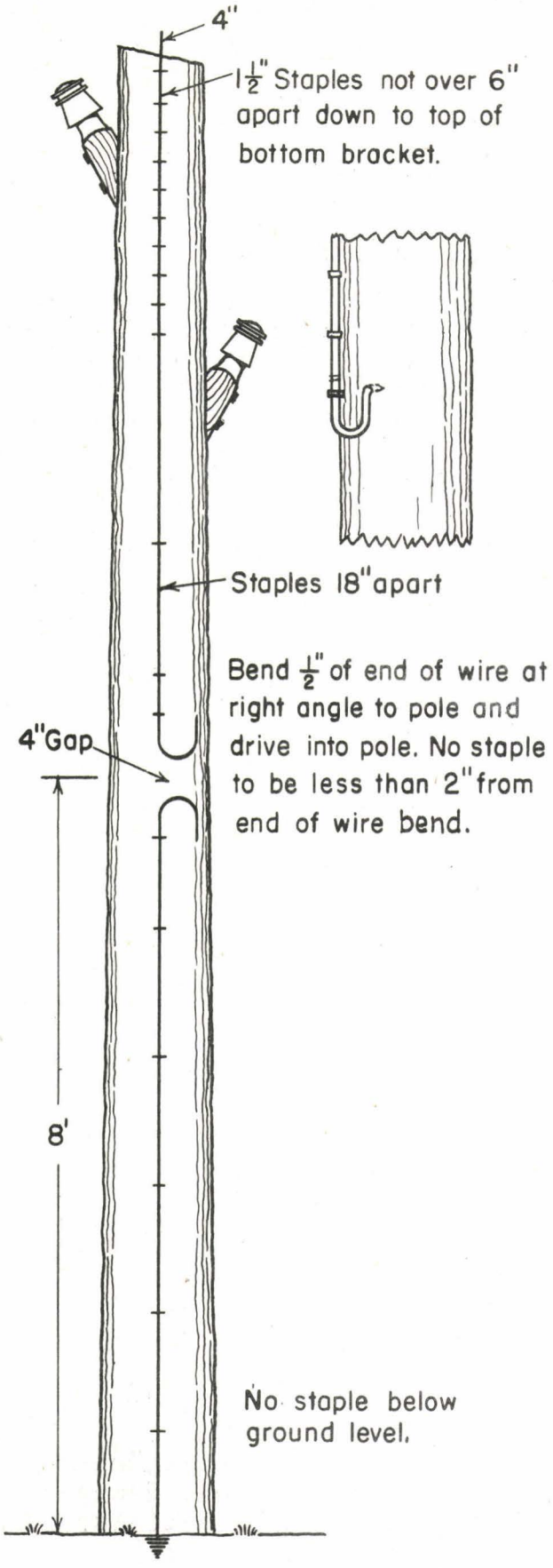
In heavy lightning zones install on every pole.

In both light and medium lightning zones install on every 10th pole.

Pole protection should not be installed on poles through timber or trees where the height of trees exceeds pole height and the distance between pole and tree does not exceed the difference between pole and tree height.

Where conductor wire is to be used for pole protection it should be attached to the pole before pole is erected, but can easily be accomplished after erection by pulling the wire to the top of the pole and extending it 4 inches above the top, stapling it 2 inches below top on back side of pole and then, with pressure on the wire applied by a man on the ground, stapling it with 1½-inch staples, 6 inches apart, to approximately the bottom of the lowest bracket. From that point down to the ground line, staples should be approximately 18 inches apart. At a point approximately 8 feet from the ground, a gap should be made in the wire in accordance with opposite sketch. The same procedure should be followed for poles not erected, except that wire sufficient to extend to the bottom of the pole should be left loose at the apparent ground line of the pole. This loose wire should be buried with the pole as it is set, but with as much earth as possible between it and the pole. See page 112 for details.

The shattering of a single pole along a line which has been in place for several years does not definitely indicate the necessity of installing protection wires. If, however, inspection indicates that several poles in the immediate vicinity of the pole shattered show evidence of splintering, or if it is known that past pole damage due to lightning discharges has occured in this vicinity, protection wires should be installed in this area.


4"
1½" Staples not over 6" apart down to top of bottom bracket.
Staples 18" apart
Bend ½" of end of wire at right angle to pole and drive into pole. No staple to be less than 2" from end of wire bend.
4" Gap
8'
No staple below ground level.

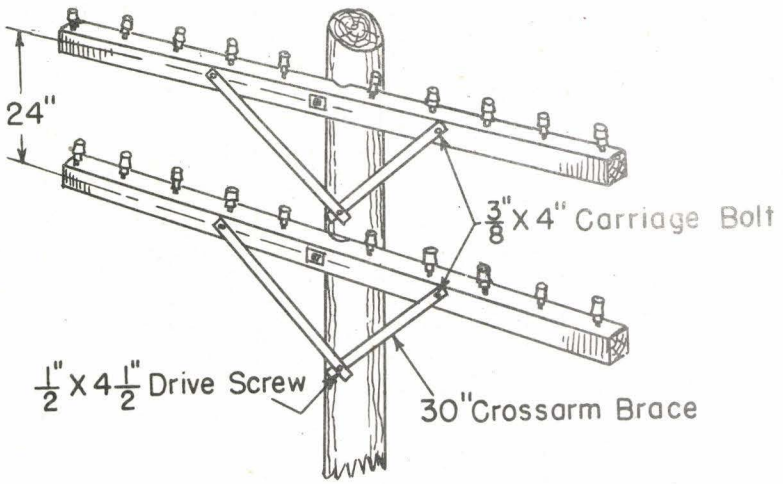
GROUND CONDUCTORS FOR POLE PROTECTION.

113. Braces, Crossarm

Braces should be attached to crossarm at warehouse during periods of inclement weather.

Two braces are required for each crossarm except extension braces on alley arms.

Braces will be placed on the face of the crossarm opposite from the face contacting the poles; this is illustrated below.



Braces, Crossarm

114. Pins

Metal pins with metal cobs or threads are standard for all new construction involving crossarms. These pins are strong and can be easily salvaged. Crossarms intended for metal pin construction should be ordered with pin holes for metal pins. This will eliminate the necessity of bushing holes which have been bored in the arms for wood pins.

Wood pins are to be used for replacement on existing arms now equipped with them.

Pins should be placed in the arm before it is attached to the pole.

115. Insulators

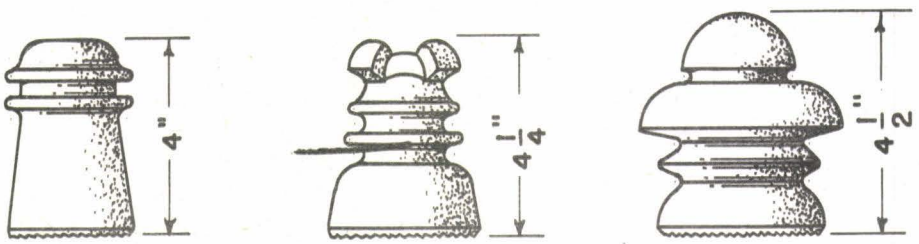
Insulators similiar to the Hemingray #16 may be used on tight tied construction where arms or bracket insulators are required.

The Hemingray #43 or similiar has both top and side grooves and may be used in arm construction where maximum insulation is necessary and where heavy grade changes are encountered. The top groove of this is of particular value in permitting top ties where sharp down grade changes occur. This insulator cannot be used for bracket construction because of its large shirt diameter.

The Hemingray #53 glass insulator or similiar should be used in all R1 transpositions. This insulator has a double groove and is well adapted for the R1 transpositions in either bracket lines or those on crossarms.

116. Insulator Placing

When placing insulators on pins or brackets, they should be screwed down, hand tight, without using force. It is best for the pins or brackets to be exposed to the weather for one or two days before attaching the insulator. This can be accomplished by either attaching them to the pole a couple of days ahead of the insulator crew, or by exposing them out of doors while still in bundles or containers. This step eliminates possible breakage of insulators from wood expansion. Use only insulators that are clean and unchipped.



A B C

INSULATORS

A - Hemingray #16 Insulator, Whitall Tatum #2 Insulator
B - Hemingray #43 Insulator
C - Hemingray #53 Insulator, Whitall Tatum #15 Insulator

117. Stringing Wire

(a) Precautions Against Damage to Wire

Line wire should be handled with care because its strength is greatly impaired by kinking or nicking. If kinks or nicks have resulted from improper handling or during shipment, they must be cut out before the wire is placed. Coils of wire from which the wrappings have been torn or partially removed during shipment should be inspected for injuries, and any injured sections should be cut out. Suitable precautions should also be taken to protect wire from being run over by vehicles, or otherwise damaged while it is being unreeled or is stretched out along the ground.

(b) Distribution of Line Wire

Distribution of line wire preparatory to stringing will depend upon the way in which the particular job is organized. In some cases the material distribution crew will leave coils of wire at suitable intervals along the line or the wire-stringing crew may carry it, particularly in cases where the wire is being strung from a reel mounted on a vehicle platform.

(c) Stringing Wire from a Moving Vehicle

(1) Line wires may be strung from a vehicle moving along the lead. This method has the following advantages over other methods of placing wire in open wire pole line construction:

Simplicity.
Elimination of damage to the wire caused by contact with obstructions on the ground.
Reduced danger to personnel stationed at the reels.
Elimination of personnel required to relay signals.
Reduction of complications at corners.

(2) Reels are mounted upon a platform and placed upon a Trailer, or in the body of a truck. Coils of line wire are placed on the reels. The starting ends of the wires are fastened at the beginning of the line. The vehicle then is moved down the line at walking speed, thus paying out the wires. Coils should be matched

according to weight so that the wires have approximately the same length. However, short coils may be spliced out as needed to reach the end of a normal stringing section. A rope is used as a brake to prevent the reels from overrunning and to maintain sufficient tension in the wires to prevent them from sagging to the ground after they have been raised.

(3) When line wire is strung from a moving vehicle, the wires should be tied off at reasonable intervals at the base of the nearest pole, usually at points corresponding to an average coil length. They should be pulled hand tight to avoid excessive sag in the section just completed.

(4) The ends of the wires in the new coils are tied off at the base of the same pole and the reel-carrying vehicle proceeds down the line. If necessary, the pole will be braced temporarily with a pike pole to offset the unbalanced load.

(d) Stringing Wires by other Means

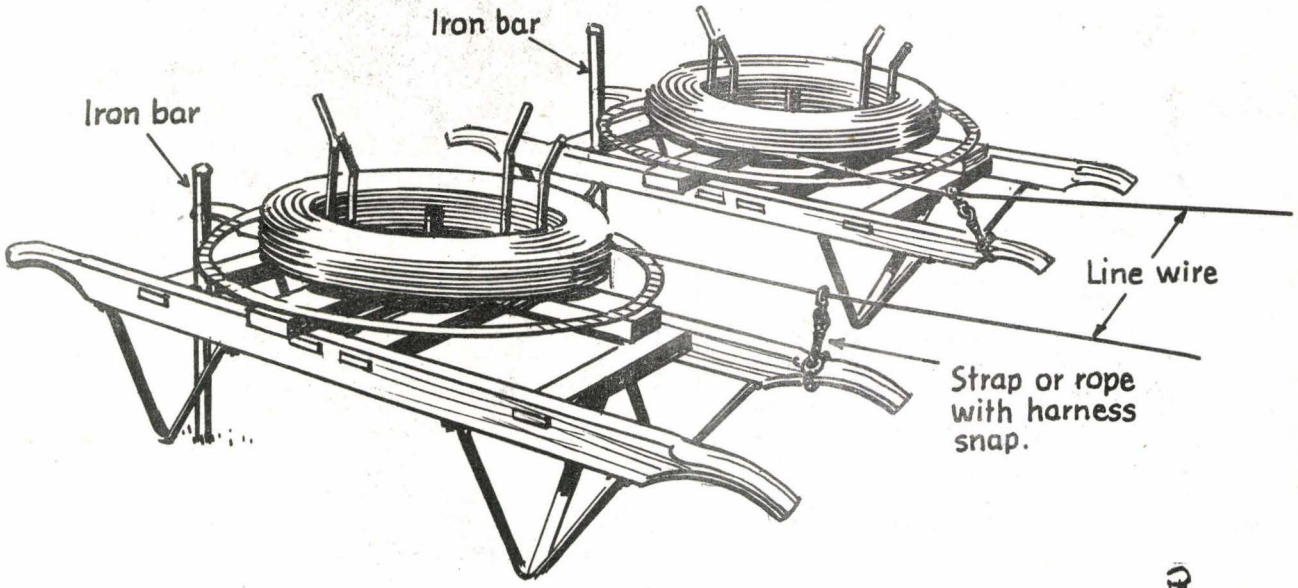
Where it is not feasible to string the wires from a moving vehicle, they may be pulled in over the crossarms by a rope which has been previously placed over the arms. This method is suggested for short distances. The reels should be brought to the beginning of the section and the wires pulled from the reels.

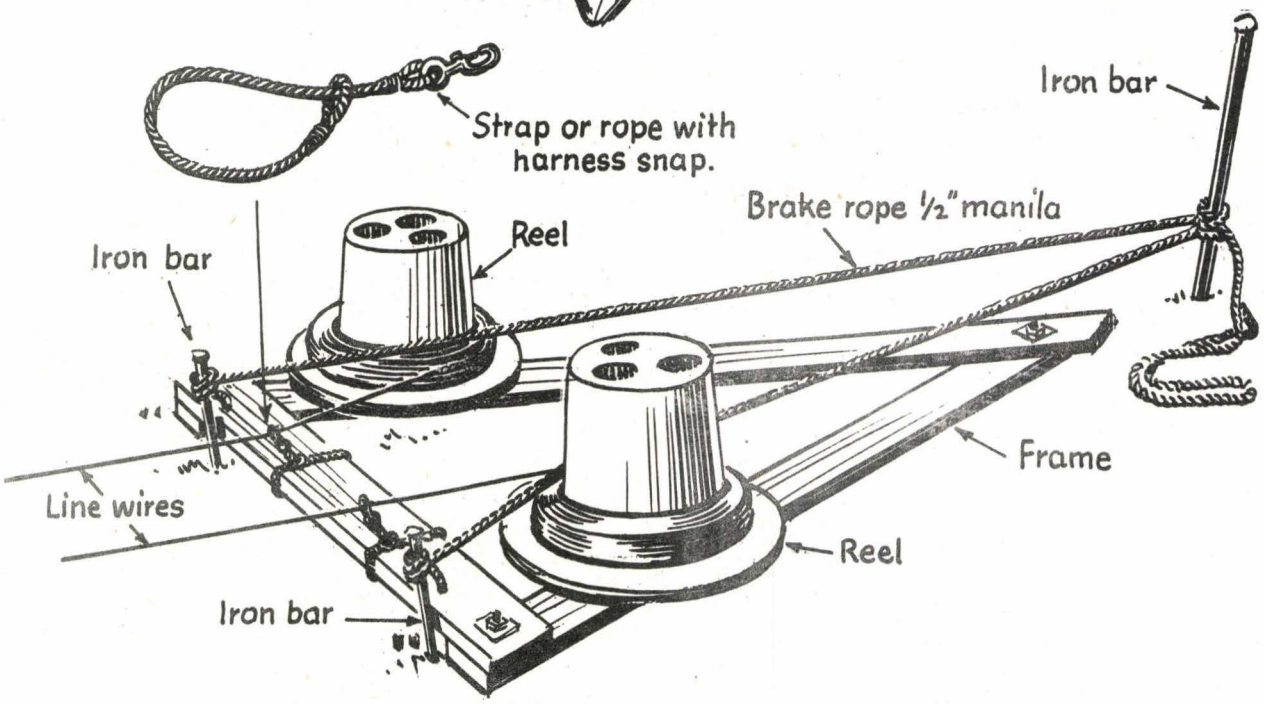
Where it is not possible to string wires by pulling in over crossarms or from reels mounted on a moving vehicle, wires may be strung from reels carried by hand, allowing the wire to pay out as the reel is carried along. For short distances the wire may be pulled along the ground from a reel. This should not be attempted in rough and rocky country. A system of signals and the personnel to relay the signals from the reel set-up to the pulling end must be provided.

(e) Use of Running Board

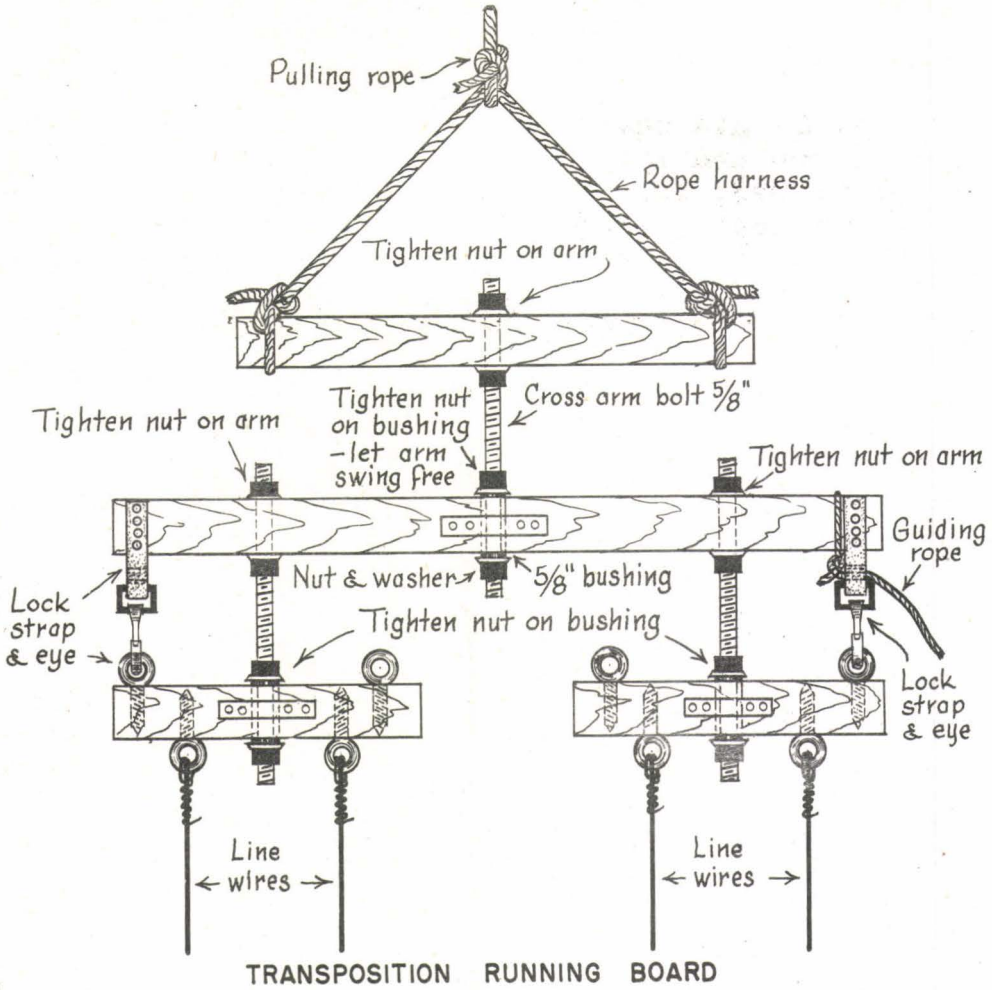
The running board is a device used to facilitate the placing of the line wires on the crossarm in accordance with the transposition plan and especially should be used in stringing wire for the R1 transposition systems. The frequent transpositions of the R1 system are easily made when a running board is used in stringing wire. Use small board for stringing two wires in R1 system, full board for stringing four wires. (See page 118).

(f) Wire may be paid out for short distances by holding the coil in hand and letting one loop off at a time. When this method is used, the coil of wire should be reversed once in every ten loops to take out the twists and to avoid kinks. Caution should be used to avoid dragging the wire for any distance over the ground. Reels fastened to a pack may be used to pay out wire from animals.





The two types of reels shown above may be used in stringing wire. Either may be used in a stationary position on the ground or truck bed and the wire pulled from them or for paying out wire from a moving vehicle.



CROSSINGS AND CLEARANCES

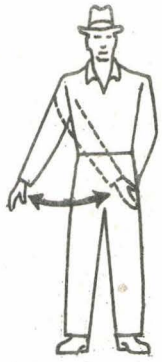
Along improved main-travel State and County roads and highways 15 feet with a minimum of 12 feet where impossible to secure full height. Over any road a minimum of 18 feet complying with local State, County, or City regulations. Along unimproved roads in rural districts 12 feet.

118. Placing wires on Poles

Where crossarms or brackets are not more than 20 feet above ground, the wires should be lifted to the arm or bracket concurrently with wire stringing. The most practical method for lifting wire to the arm or bracket is by the use of a forked stick, light enough to be handled by one man. For higher than 20 feet, it will be necessary to carry the wire or wires up or use a hand line. If the wires are tight, they should always be pulled up with a hand line. The wire should never be attached to a lineman's body or clothing while being lifted up. Wire should not be pulled forward while it is being lifted up.

SIGNAL DIAGRAM — DETAILS OF SIGNAL

(A) GO AHEAD

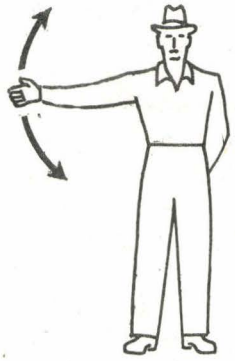


Swing either arm extented full length in arc across front of body.

(B) GO AHEAD SLOWLY

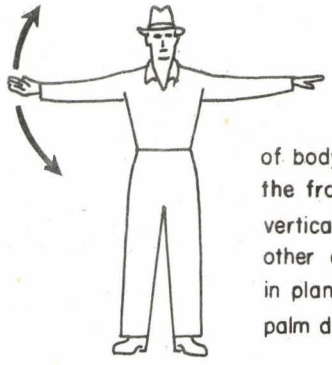
Swing either arm extended full length in arc across front of body. Extend other arm horizontally in plane of body with palm down.

(C) BACK UP



Extend either arm horizontally in plane of body with palm to front, and execute vertical arc.

(D) BACK UP SLOWLY

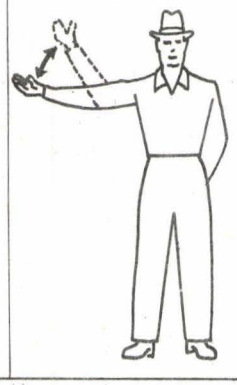


Extend either arm horizontally in plane of body, with palm to the front, and execute vertical arc. Extend other arm horizontally in plane of body with palm down.

(E) STOP

Extend both arms full length above head, with palms to the front.

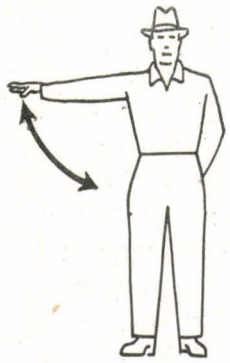
(F) UP



Extend either arm horizontally in plane of body, with palm of hand up. Execute short swings with forearm upward and back to horizontal.

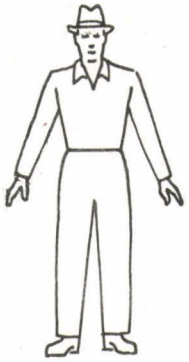
SIGNAL DIAGRAM — DETAILS OF DIAGRAM

(G) DOWN



Extend either arm horizontally in plane of body, with palm of hand down. Execute short swings with arm downward and back to horizontal.

(H) HOLD

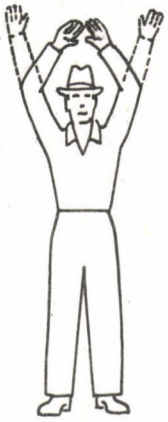


Extend arms full length in plane of body to angle of 45°, palm of hand down.

(I) RELEASE OR CUT OFF

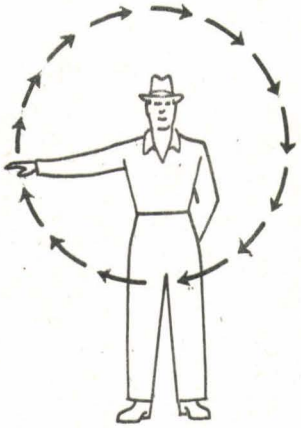
Extend both arms to horizonal position on either side of body. Swing arms horizontally in opposite directions in short vertical arcs.

(J) ALL O.K.



Extend both arms full length above head, with palms to the front. Swing both arms horizontally in short arcs in plane of body.

(K) RETURN OR GO BACK



Extend either arm full length horizontally in plane of body. Swing in arc extending across front of body.

119. Streets, Highways, Roads, Over

Over all roads streets and highways including Forest roads and trails a minimum of 18 feet, more if necessary to comply with local State, County or Municipal regulations.

Special precautions are necessary to prevent accidents while stringing wires across streets, highways, or railways. Where traffic can be held up for a few minutes, proceed across the crossing as though it were the usual type span. Men should be stationed at the poles, adjacent to the crossing to place the wires over the crossarm or brackets and to pull them up immediately after the wires have been strung between the two poles. They should be pulled up over the crossing clear of any traffic. Tension should be maintained on the wire to insure adequate clearance in the crossing span. If traffic cannot be held up, use an auxiliary rope support as for stringing wires over power circuits. (See page 124)

In either case, traffic flagmen should be stationed during the work operation an adequate distance from such crossings to stop or slow the traffic before it reaches the crossing.

120. Railroads, Over

The clearance of open wire or cable construction over any railroad should be made to comply with the company requirements which is usually 30 feet. All lines should be deadended on poles set off of the railroad right-of-way but no crossing span should exceed 150 feet.

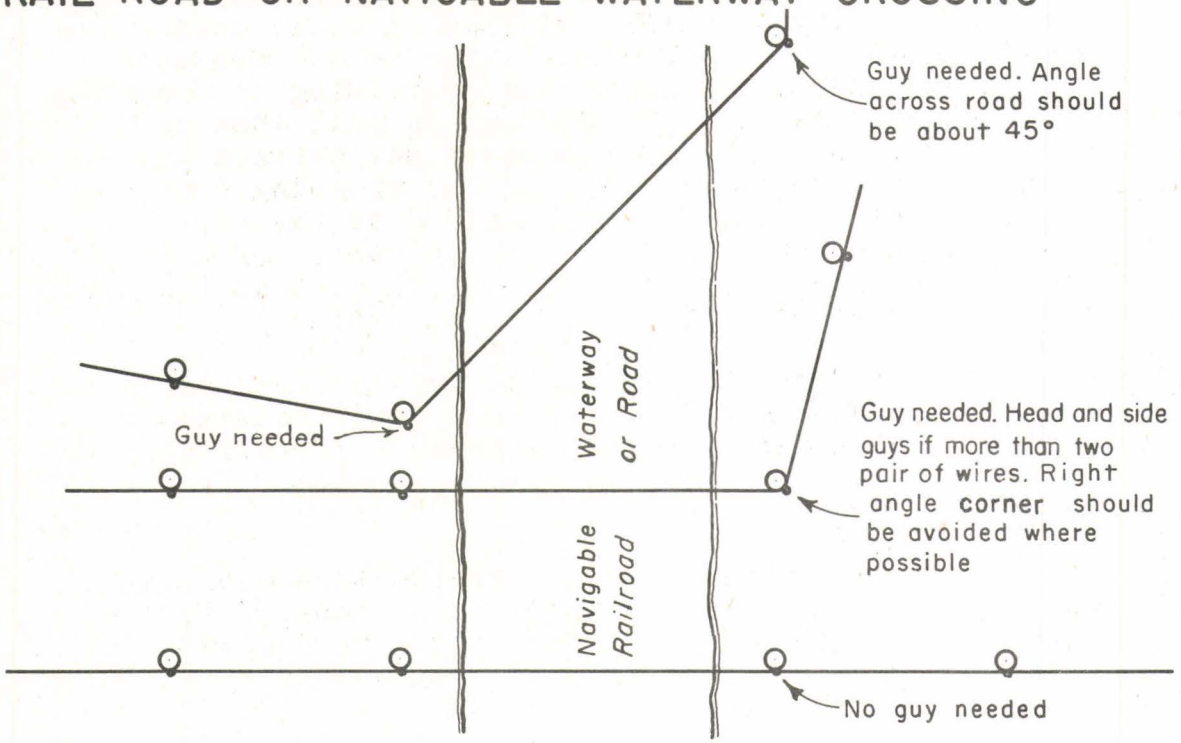
121. Waterways, Over

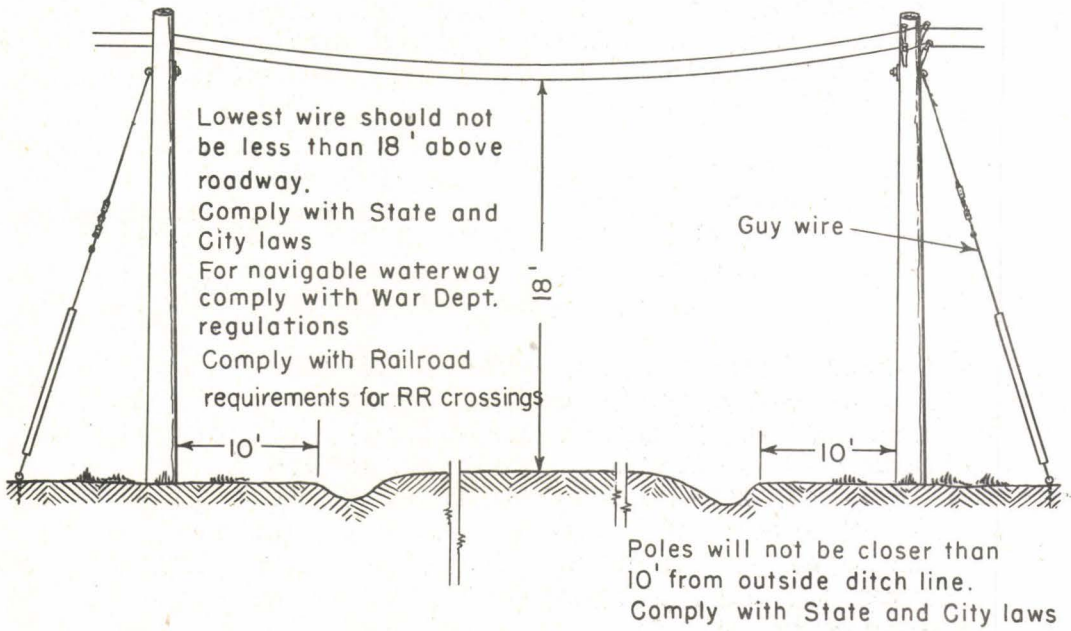
Clearance over waterways to be specified in detailed plans and is dependent upon whether stream is open or whether navigation is possible. Crossings over navigable streams should comply with War Department Regulations.

Waterway crossings for non-navigable streams should be of sufficient height to prevent damage by high water. Where practicable the approaches to the stream should be on high ground. For navigable streams the clearance regulations issued with the crossing permit by the War Department should be followed.

Stringing wire over fast-flowing streams is hazardous. Extreme care should be used. The most logical location for a stream crossing is either on a bridge or immediately adjacent to one on the downstream side. Where no such structure is available, the water too deep to wade and too wide to throw a line (cord) across, the use of a boat will be necessary. The reel should be placed in the boat and paid out from the stern. Experienced boatman and a boat of adequate capacity are necessary. Right-of-way from the stream to the first structures on each side should

HIGHWAY
RAIL ROAD OR NAVIGABLE WATERWAY CROSSING


Guy needed. Angle across road should be about 45°
Guy needed
Waterway or Road
Guy needed. Head and side guys if more than two pair of wires. Right angle corner should be avoided where possible
Navigable Railroad
No guy needed


Lowest wire should not be less than 18' above roadway.
Comply with State and City laws
For navigable waterway comply with War Dept. regulations
Comply with Railroad requirements for RR crossings
18'
Guy wire
10'
10'
Poles will not be closer than 10' from outside ditch line.
Comply with State and City laws

be well cleared and brush removed in advance of any wire stringing. Number 12 copper-covered wire should be used as a pulling line and strung first. This wire should be on both structures adjacent to the stream and pulled up clear of the water. Where more than four wires are to be strung, the pulling wire should be in excess of twice the length of the crossing span to enable its being pulled back. All of the above are general. Every such crossing will present its own problems. Good planning to meet and overcome these problems is necessary. Stringing wire across streams presents added hazards to the life of both the foreman and his crew. Safety planning is necessary. Men working on watercraft should be equipped with life preservers.

Where poles with sufficient lengths are not available to meet the clearance requirements, submarine cable should be used.

The methods for installing submarine cable vary between eacn stream and body of water. Surveys are necessary for crossing under navigable waters the same as for overhead crossing. The volume of stream flow and its speed are necessary factors in arriving at the amount of weight to be used in holding the cable on the bottom. Inland lakes present difficulties not encountered in streams. However, there are some general methods which should be used. Two methods which can be used for laying the cable, each depending upon physical conditions, are:

(a) Pulling the cable across with a pulling wire or rope strung from the opposite bank.

(b) Reeling the cable out from a boat.

Midstream anchors may not be required in either of these methods. When using a boat, two targets about 100 feet apart should be set up on the opposite shore from the fastened end of the cable to facilitate the boatman's keeping the boat on the proper course. It would be wise to make, under some conditions, a trial run of the boat fully loaded with required number of men and material. Care should be exercised to prevent excess cable from being unreeled, but also sufficient cable should be reeled out to permit it to lie on the bottom of the stream bed throughout its length.

The cable should be buried underground from a point less than the low-water mark to the open wire fixture. The depth varying, depending on soil types and its use. The cable should be run up the open wire fixture on the down-stream side if there is any possibility of high water reaching it.

Detailed surveys should be made of all such crossings well in advance of construction. Shore fixtures should be placed on high ground where practicable and should be well guyed. Painted warning signs should be placed on each shore of navigable bodies of water reading as follows: "Warning, Cable Crossing, Do Not Anchor". These signs should be placed so they are readable from both up and down stream. Lightning protection at each end of the cable should be provided; the ground resistance should not be higher than 10 ohms.

122. Over Power, Trolley, or Light Wire

Crossing over power wires will be allowed only for power circuits of 2300 volts or less. A four foot minimum clearance should be provided considering the maximum sag for the upper wire.

Overhead crossing of power, trolley, or light wires by open wire method is limited to wires carrying 2300 volts or less. For voltage 500-2300 the overhead crossing job should be contracted to the Power Company. However when this is not possible an experienced foreman should be in charge. A reliable and experienced lineman, having had experience in working on joint-use poles, should be available to supervise and assist in the work. All men handling wire or rope while crossing power wires, or wires on joint-use poles, must wear rubber gloves (see material standards) until all of the wires have been spliced, pulled up, and tied in.

The methods outlined in the following paragraphs must be rigidly followed in order to prevent contacts with wires carrying power voltage:

(a) Secure a 1/2-inch rope equal in length to at least twice the distance between the crossing poles plus twice the height of the crossarms above the ground. The pulling line and the 1/2-inch rope must be dry manila rope, free from all metallic strands.

(b) Throw a hand line over the power wires, attach the 1/2-inch rope and the pulling line and pull both ropes across the power wires. After this is done, lift both ropes up and over the crossarms of the crossing poles. All of the surplus length of the 1/2-inch rope should be located on the reel side of the crossing except enough to reach the ground on the pulling side.

(c) Attach the pulling line to the running board.

(d) Place a loop of houseline or other small rope around the wires as close as practicable to the running board. Attach each end of this loop to the 1/2-inch rope by means of two halfhitches. Similar loops should be placed at 3-foot intervals as the wires are pulled over the span.

(e) As the wire is pulled, the 1/2-inch rope should be held taut and pulled across the crossing span at the same rate of speed as the wire.

(f) When the running board has reached the pole on the pulling side of the crossing, the 1/2-inch rope should be made fast at each pole.

(g) Pulling of the wire may then continue.

(h) After the wires have been drawn taut and snubbed securely, so as to prevent their sagging down into contact with the electric light, power or trolley circuits below, the 1/2-inch rope may be withdrawn from the crossing span.

Minimum vertical clearance between any part of the telephone construction and any part of a power line should be made according to requirements secured from the power company, but in no case should clearance be less than the following minimum clearance standards:

For power line voltage not exceeding	Vertical Clearance
7,500 volts	4 feet
17,500 volts	6 feet
120,000 volts	10 feet
220,000 volts	15 feet

When crossing under high voltage transmission lines, the telephone lead should be built at right angles to the power line and within 10 to 35 feet of a power line pole or tower. This provides some additional protection from power contact in case a power wire should fall and also offers better clearance opportunities.

123. Crossing Under Power Lines

Best engineering evidence indicates that the use of a protection guard is not warranted and that maximum protection is offered by

the required standard of power transmission line installation itself. However, in the event of the necessity of such crossing, installations will be made on the basis of full consultation with power company representatives as to acceptable structural features. In any event, when the power transmission line is carrying 3200 or more volts, the type 99-A power protector developed by Western Electric will be installed on the poles on each side of the power line. The purpose of the 99-A Protector is to limit to a value less than the capacity of the station protector the voltage impressed on service connections through a power contact with the telephone circuit. The 3200 volt figure mentioned before is a guide only and there may be certain conditions which will make the use of the protector advantageous at lower voltages. Proper grounding of the protector is of the utmost importance and should have particular attention. The resistance should not exceed 100 ohms.

Telephone circuits may be carried aerially under any power circuit, provided local regulations do not prohibit such crossings, and where specified clearances can be obtained, right-of-way crossing permission can be secured from the power line operator, and approved protection devices are applied to the telephone line. Such crossings may be made by open wire or construction on a messenger cable.

In stringing wires under electric light or power circuits, use all means to protect the personnel from electric shock. All wires on power lines, including guys, must be treated as dangerous. Workmen should not permit, at any time, wires which are being strung or worked with to contact any part of a power line system including guys, crossarm braces and metal parts such as bolts, nuts and washers. All workmen who handle wires, metal parts, or treated poles and braces which may come in contact with and be charged with power voltage must wear rubber gloves. Foreman and workman should understand that when working close to a high power transmission line that danger exists even though no actual contact with any of the power wires has been made. Voltage may be inducted from these transmission lines which could be fatal to a workman while raising a pole or while working on a pole if a direct current path to the ground is possible. Ground wires should be left off such poles, especially if the power poles and wires are higher than the telephone poles and line. Freshly treated creosoted poles furnish a good path for electrical currents. Be careful always!

124. Joint Use and Parallel to Power Wires

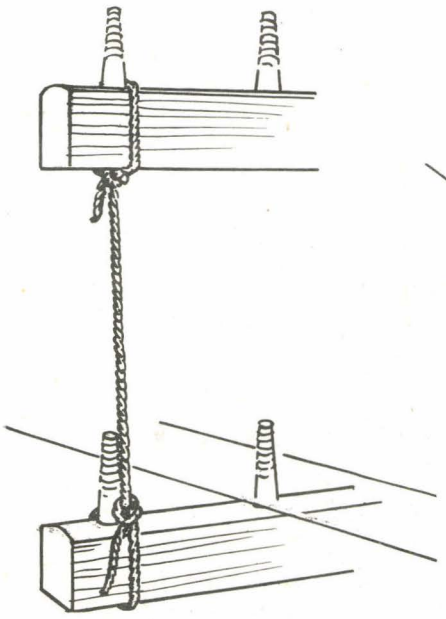
Where wires are being strung on a section of a line occupied jointly with power circuits in the upper position, or where

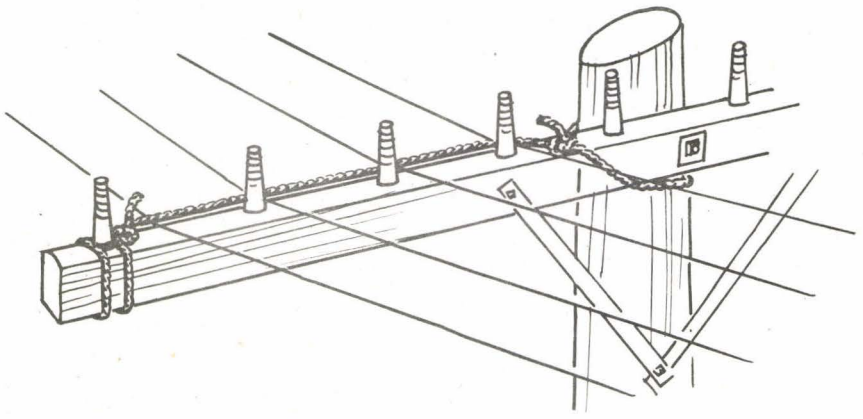
a power line is built over the telephone line on separate poles, precautions should be taken to hold down the wires being strung at each pole, whenever there is a change of grade upward. If this is not done, the wires will tend to rise and, in some cases, might come into contact with the power wires.

On jointly used lines, where wires might slack down temporarily and catch under branches or trees below the line, such locations should be observed closely and precautions taken so that wires will not whip up into the power wires above, upon being released. Ease sleeve connections over crossarms or other obstructions to prevent the wire's catching with resultant abnormal tension being introduced in the wire. This is especially important where the smaller sizes of wire are being placed, as the wire might become broken and snap up into the power wires.

In cases where there is a sharp change of grade upward, at a pole with a crossing of power wires above, place the pay-out reels at the foot of the pole and pull the wires in both directions from this point. Place the truck or other pulling equipment so that the pull may be stopped promptly when desired.

To prevent wires from rising when being strung on the top telephone crossarm, tie a rope around the end of the crossarm and then stretch it across the arm and over the wires to the pole where it is tied again. The rope will prevent an upward lift. To prevent the wires from rising and slipping off of other than the top crossarm, tie a rope at the outer end of the crossarm holding the wires and extend it to the crossarm immediately above it. The rope will hold the wire between the two arms.





Use rope while stringing wire to hold wires on arms where pull may be out or up.

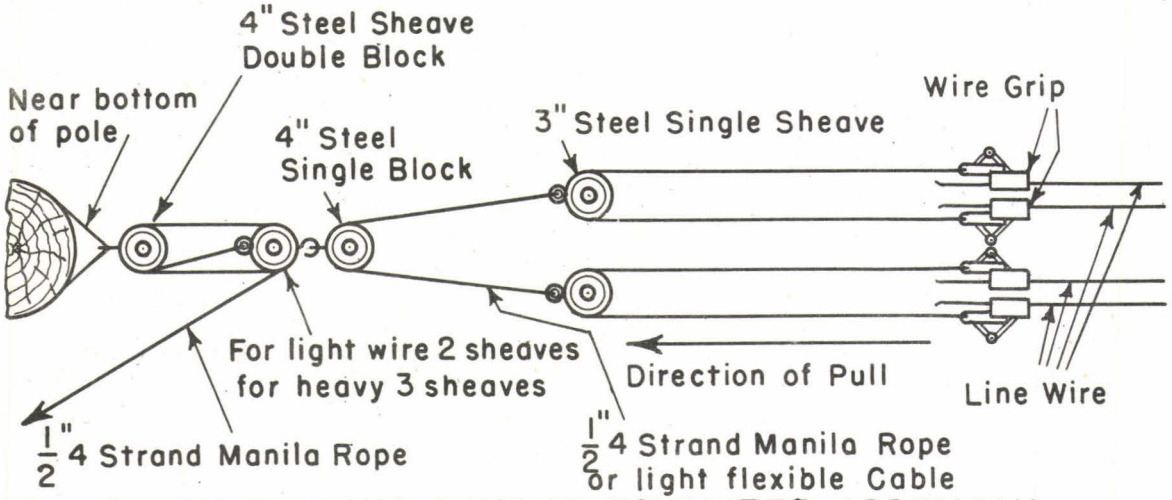
125. Pulling Slack

Slack will be pulled from the first transposition pole and from each succeeding transposition pole thereafter. Each unguyed transposition pole should be guyed temporarily to counter the wire strain.

When four wires are being pulled up, use double equalizer as shown, except when pulling up for dead-ending or point transpositions, in which case use blocks on a single wire.

Each "tying-in" crew should have at least two line-wire, smooth-jaw grips (No. 6 wire and smaller) for each wire to be pulled. To snub off a wire, use a grip with a rope attached to hold slack and to avoid kinking the bending of wire. Use only smooth-jawed grips on line or guy wire.

Slack should be pulled from one transposition point to another except in R1 systems. Men should be spaced about every third pole, angle poles preferred to shake the wire and equalize the slack. The "tying-in" crew should release the holding grips and remove temporary guys as it moves forward.



SLACK PULLING DOUBLE EQUALIZER ASSEMBLY.

126. Splicing and Connecting Line Wires

(a) Permanent Splices

The perfect telephone line would consist of continuous lengths of wire with no splices. Obviously this would not be practicable in many instances. Handmade splices have been a principal source of excessive noise and trouble in Forest Service Telephone circuits. Therefore permanently made connections or splices should always be made with a compression type sleeve. For practical purposes, there are three prime considerations that should be kept in mind when splices are made:

(1) The splice should be as strong as the wire itself.

(2) The splice should not introduce resistance to the wire that will unbalance the line and cause noise or loss of transmission.

(3) The splice should be free from corrosion.

The correct selection of the sleeve and tool to fit the wire size and the correct application of the sleeve will result in mechanical strength equal to or greater than the line wire itself. Watch for undersized wire that has been stretched due to abnormal loading -- this is usually only found in the case of No. 9 Iron in heavy loading areas. The remedy for this condition is to eliminate the sub-gauge section of wire.

Properly installed sleeves do not introduce any appreciable resistance to the line.

Corrosion will almost invariably take place when two conductors of unlike metals are brought into contact with each other. It is, therefore, necessary to make sure that a sleeve for joining dissimilar metals is used.

Where junctions are made with a branch lead, there should be sufficient dead-ending slack of the side conductor to avoid placing a strain on the sleeve used to connect the branch lead to the main line.

(b) Temporary Connections

It is often necessary to make temporary connections to lines and in some instances to make a connection that is detachable for test purposes. The bridging connectors listed in the materials standards should be used for this purpose. These connectors are not suitable to stand the strain of the line tension and should not be used in that manner. Some degree of maintenance (annual at least) is required to keep the resistance of connections made with bridg - ing connectors acceptably low. Such maintenance consists of cleaning and tightening. Where the joined wires consist of different metals it is very important that the correct connector be used to avoid corrosion.

(c) Emergency Splicing

A standard wrapped splice is permissible for emergency repairs but is to be replaced with a sleeve splice at the first opportunity. Some method of marking or recording of emergency splices should be made to assure that they are not overlooked and allowed to accumulate in the line. Wrapped splices on copper-covered steel are particularly unsatisfactory as the wire is so stiff that a tight wrap cannot be made without damaging the wire.

General and specific instructions of currently popular compression type tools, 31 DJ, 31 CJ, and 51 PJ, and sleeves follow. For obvious reasons the instructions for other compression type tools and sleeves are not included herein.

All sleeves and tools are stamped with identifying numbers and letters. The sleeve, in addition to a stock number, is stamped with the groove letter, the tool by number and letter, as (51 PJ), and the tool groove by letter as (P). The groove letter is found on one side of the jaw, close to the corresponding groove. The groove letter on the jaw should always correspond with the letter on the sleeve. Always be sure the letters are identified before applying compression.

Compression type splices require that the ends of both wires be clean for slightly more than half the length of the sleeve. This is necessary regardless of its being old or new wire. Use abrasive paper made especially for this purpose or #00 emery cloth, or a fine grade of steel wool. Do not scrape with a knife or wear through the galvanizing or copper.

Keep the sleeves in the original package. Do not allow them to be damaged or corroded while in storage, or on the job. They, like line wire, must be clean.

(d) Methods of Line Splicing

For line splicing, push wires into sleeve until they strike the center stop. Do not twist the wire. If it will not go all of the way into the center stop, remove and straighten it, and clear the burrs from the cut end; then push straight in. Never twist. See Fig. A

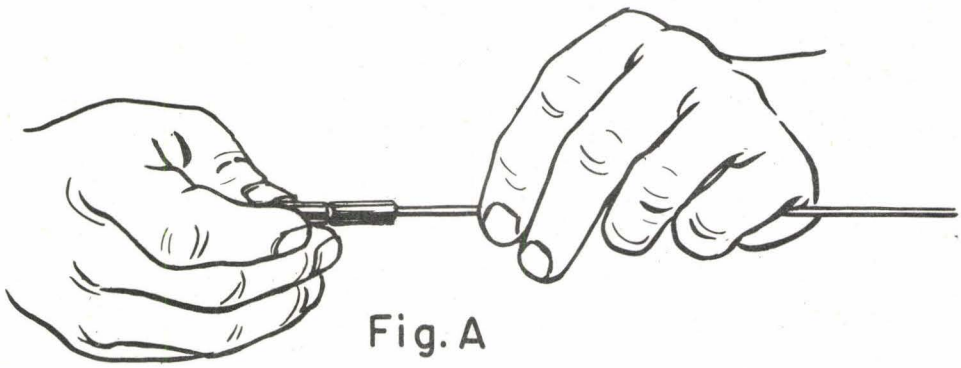


Fig. A

Pinch sleeve with cutting pliers at each side of center only enough to hold the wires from sliding out of position before splice is finished. See Fig. B.

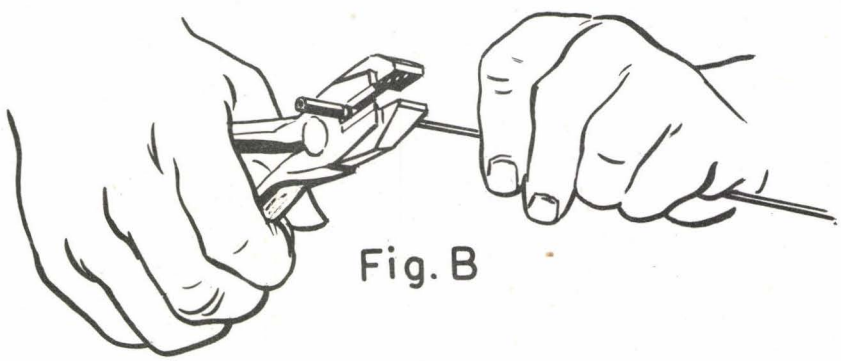


Fig. B

First make the two inside squeezes, one on each side of the midpoint of the sleeve closing the tool on each squeeze until the bumpers meet. Then continue making squeezes, working progressively from the midpoint of the sleeve to each end until the entire sleeve is compressed. There should be about 1/16" space between compression points. The handles in the illustration are open at the correct position at the beginning of the compression. See Fig. C.

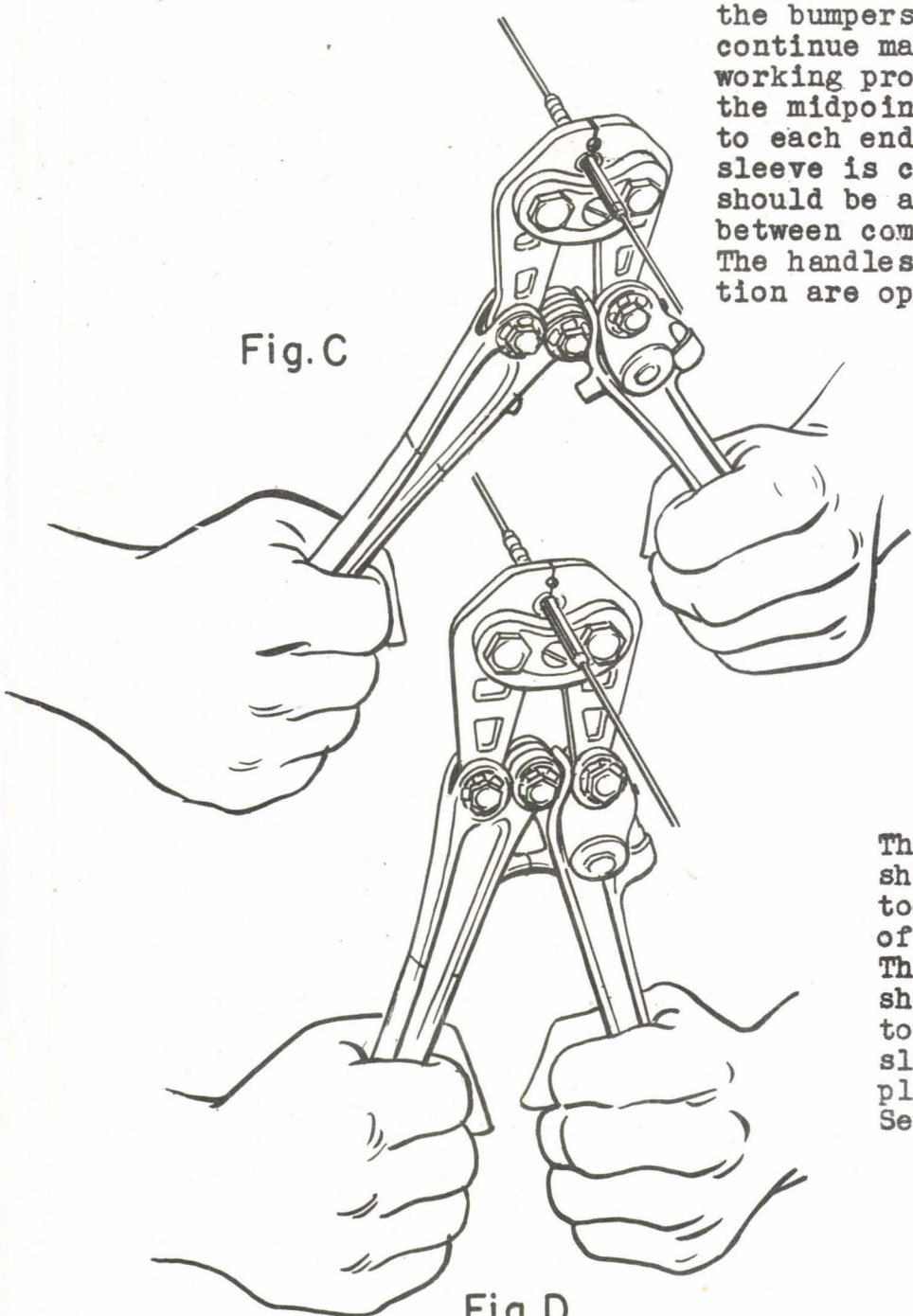


Fig.C

This illustration shows position of tool at completion of compression. The handle bumpers should always touch when the sleeve is completely compressed. See Fig. D.

Fig.D

Below are two illustrations of a compressed sleeve. One (Fig. E) is the exterior shape, and the other (Fig. F) the interior shape. The interior view illustrates not only the necessity of clean wire and sleeves, but also the importance of having the compression tool properly adjusted and the compression thoroughly made by following through with the tool squeeze until the handle bumpers touch. Note the fusing of sleeve and wire metals.

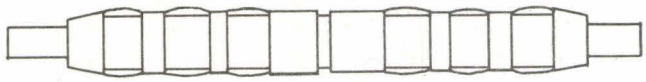


Fig.E

The above illustration (FIG. E) shows the exterior shape of a compressed sleeve.

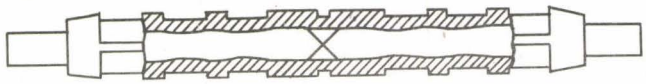


Fig.F

The above illustration (FIG. F) shows the true interior shape of a compressed sleeve. It illustrates the necessity of clean wire and sleeves.

The diameter of the compressions should be checked occasionally with the gauge furnished with each tool. For further data on cleaning and adjusting compression tools, refer to "Tools" in the appendix. The gauge (Fig. G) should be kept with the tool at all times.

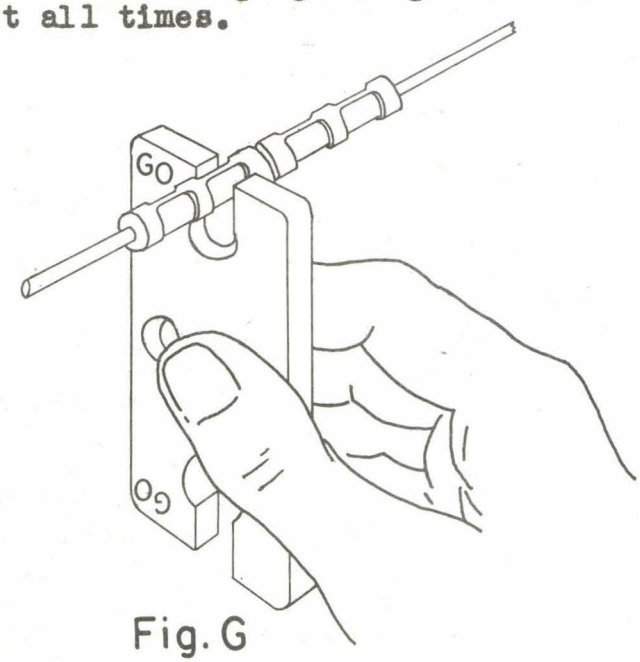
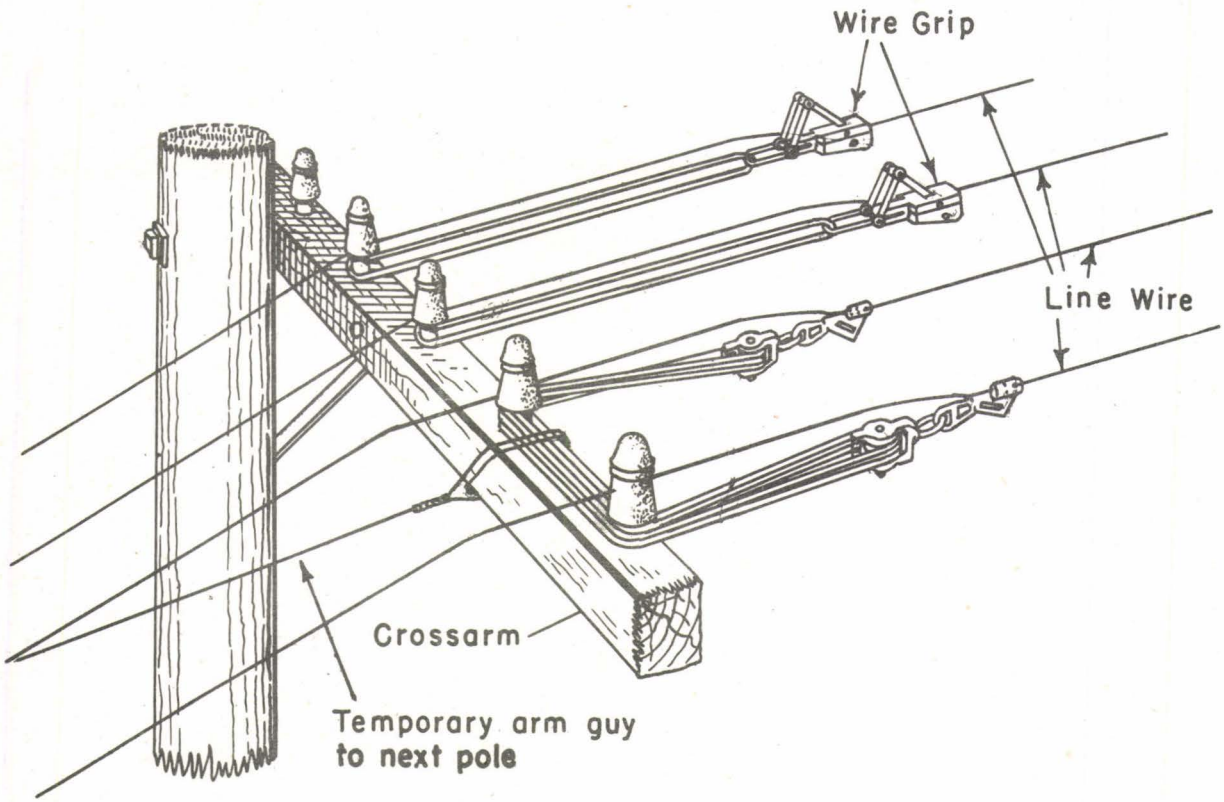


Fig. G



ALTERNATE SNUBBING METHODS

127. Sags

There are several methods of determining when the line wires have been pulled up to the proper sag or tension such as the oscillation, tension in pounds of pull, and the sight method. All are based on gauge of wire, span lengths, and temperature. The sight method shown below has been adopted as standard by the Forest Service because of its simplicity and all-round accuracy.

Before tying wires to insulators, pull them up somewhat tighter than required and then slacken them slightly. Select a span of average length, about 10 poles from the dead-end point or point where the wire is permanently connected to a previously pulled wire, and hang a sag gauge on the crossarm at each end of the selected span.

Set the target on each gauge so that it coincides with the figures corresponding to the amount of sag specified in standard sag tables for that particular length of span, kind of wire, and temperature. Better results can be obtained by offsetting the targets on the crossarms. For example, in

sighting on No. 3 wire, set one target against pin No. 1 and the other target against pin No. 5 at the opposite end of the span.

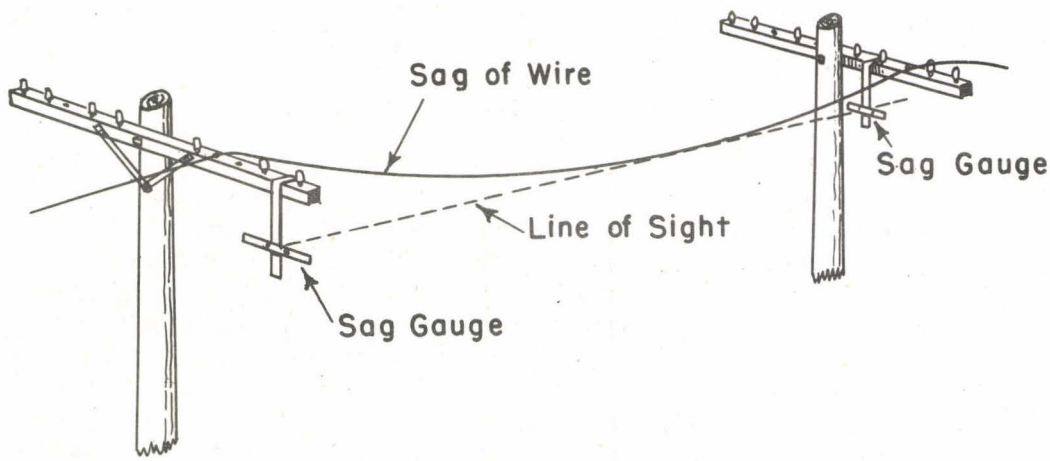
Sight across from the top of one target to the top of the other and, with the wire resting on the top of the crossarm, adjust the sag in the wire by pulling up or slacking back until the lowest point in the span is in line with the tops of the targets.

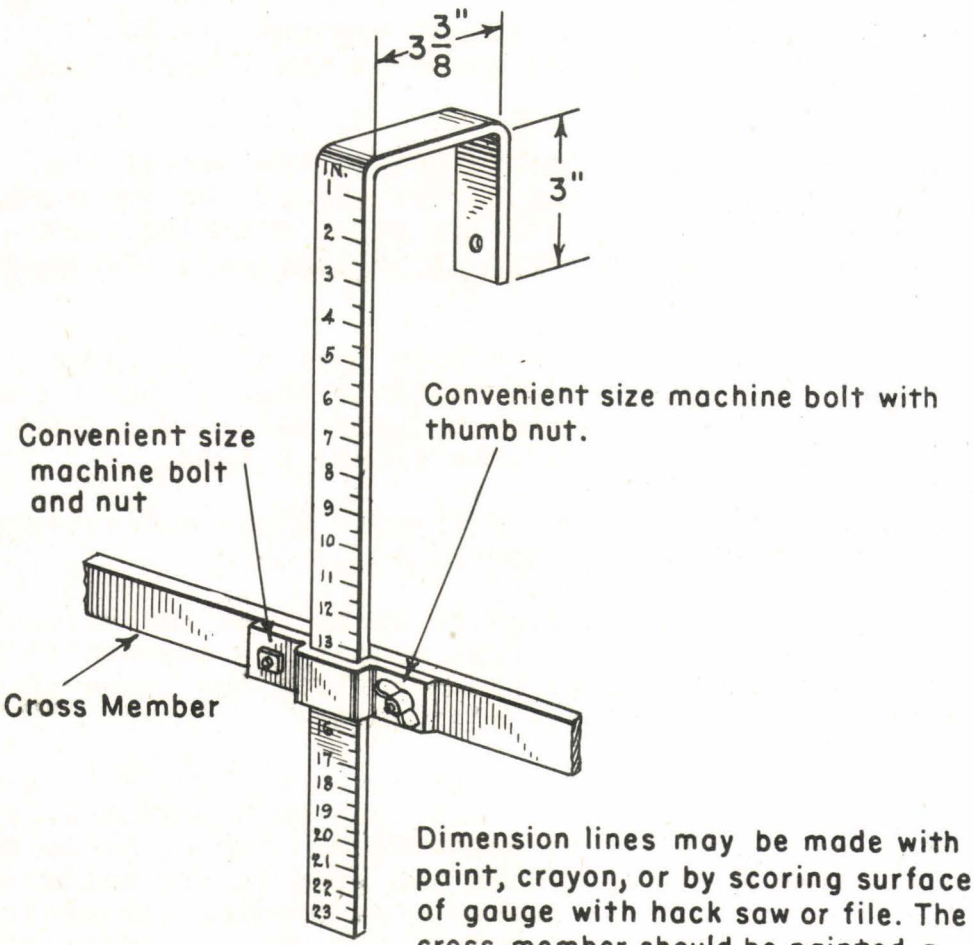
For bracket-line construction, the hook part of the gauge should be placed in a relative position to that on the crossarm. This can be effected either by holding or by a spike driven slightly into the pole at the proper height.

The sag tables give the sags for different kinds and sizes of wire for various temperatures, spans, and loading.

In selecting the proper sag for given spans, use the value in the sag table for the span length within the nearest 10 feet. Obtain the shade temperature of the air along the route of each span being measured, by use of a thermometer.

Example: For obtaining the sag where the shade temperature is 83° and the span is 130 feet long in a medium loading area, using the "Light and Medium" loading table for #9 galvanized wire: Look down the span length column until 130-foot span is found, then reading across it will be found that under 80°, the nearest temperature to the actual 83°, the specified sag is 10 inches.




3 3/8"
3"
IN.
Convenient size machine bolt with thumb nut.
Convenient size machine bolt and nut
Cross Member
Dimension lines may be made with paint, crayon, or by scoring surface of gauge with hack saw or file. The cross member should be painted a bright color preferably yellow

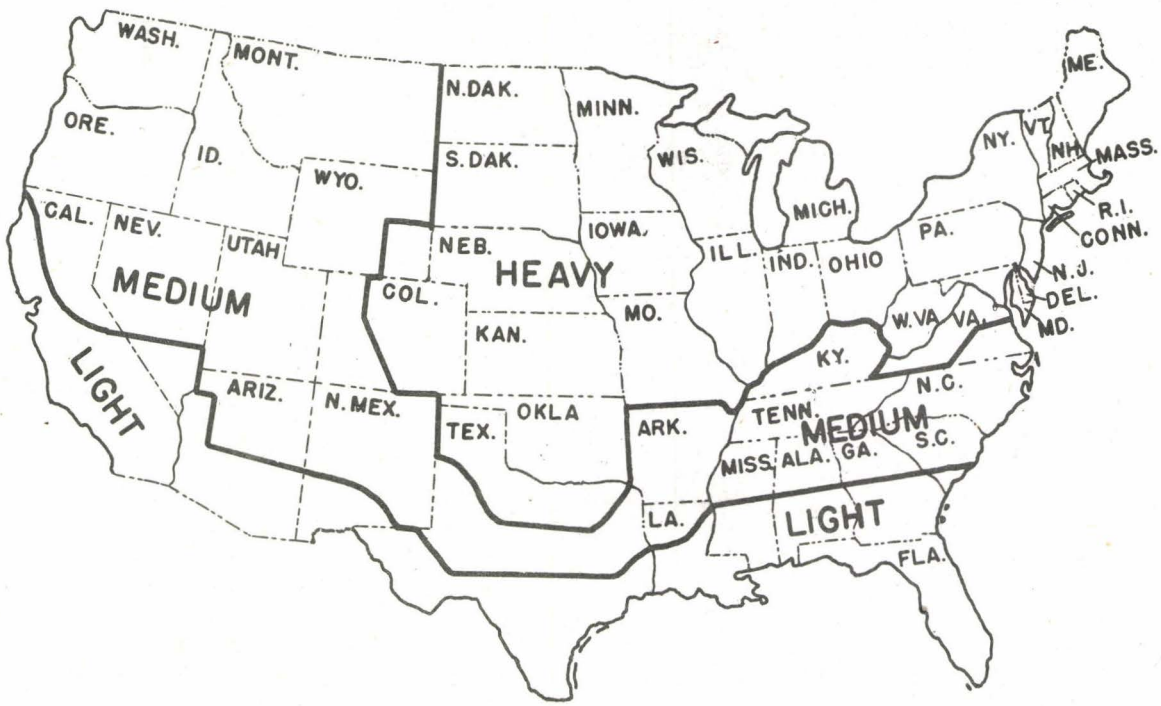
SAG GAUGE

128. Conductor Loading

The loading on conductors shall be assumed to be the resultant loading per foot equivalent to the vertical load per foot of the conductor, ice-covered where specified, combined with the transverse loading per foot due to transverse horizontal wind pressure upon the projected area of the conductor, ice-covered where specified to which equivalent resultant shall be added a constant. In the tabulation below are the values for ice, wind, temperature and constants which shall be used to determine the conductor loading.

	Loading District		
	Heavy	Medium	Light
Radial thickness of ice (inches)	0.50	0.25	0
horizontal wind pressure (pounds per sq. ft.)	4	4	9
Constant to be added in pounds per sq. ft.):			
For bare conductors of copper, steel copper alloy, copper covered steel, and combinations thereof.	0.29	0.19	0.05
For bare conductors of Aluminum (with or without steel reinforcement	.31	.22	.05
for weather proof and similar covered conductors (all materials)	.31	.22	.05

Extreme or extra heavy loading exists when the conditions for heavy loading are exceeded and construction should be planned accordingly.



General Storm Loading Areas in the United States
(Regions should define local areas where loading is known not to agree with above)

Stringing Sags for
#8 B&S and #10 B&S Hard-drawn Copper Wire
#9 BWG Galvanized Iron Wire

Medium and Light Loading District

Temperature - Degrees Fahrenheit

Span Length (Feet)	20	30	40	50	60	70	80	90	100	110	120	Span Length (Feet)
					Sag in Inches							
100	4.0	4.5	4.5	5.0	5.5	6.0	7.0	8.0	9.0	10.0	11.0	100
110	5.0	5.0	5.5	6.0	7.0	7.5	8.5	9.5	10.5	12.0	13.0	110
120	5.5	6.0	6.5	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	120
130	6.5	7.0	7.5	8.0	9.0	10.0	11.0	12.5	14.0	15.5	17.0	130
140	7.5	8.0	8.5	9.5	10.5	11.5	13.0	14.5	16.0	17.5	19.0	140
150	8.5	9.0	10.0	11.0	12.0	13.0	15.0	16.5	18.0	19.5	21.0	150
160	9.5	10.0	11.0	12.0	13.5	14.5	16.5	18.5	20.5	22.0	23.0	160
170	11.0	11.5	12.0	13.5	15.0	16.5	18.5	21.0	23.0	25.0	27.0	170
180	12.0	12.5	13.5	15.0	17.0	18.5	21.0	23.0	25.5	28.0	31.0	180
190	13.5	14.0	15.0	17.0	19.0	20.5	23.0	26.0	28.5	31.0	34.0	190
200	15.0	15.5	16.5	19.0	21.0	22.5	25.0	29.0	31.0	33.0	36.0	200

Stringing Sags for
#8 B&S and #10 B&S Hard-drawn Copper Wire
#9 BWG Galvanized Iron Wire

Heavy Loading District

Temperature - Degrees Fahrenheit

Span Length (Feet)	20	30	40	50	60	70	80	90	100	110	120	Span Length (Feet)
					Sag in Inches							
100	4.0	4.5	5.0	5.5	6.0	6.5	7.5	8.5	9.5	10.5	11.5	100
110	5.0	5.0	6.0	6.5	7.0	8.0	9.0	10.0	11.5	13.0	14.5	110
120	5.5	6.0	7.0	7.5	8.5	9.5	10.5	12.0	13.5	15.0	16.5	120
130	6.5	7.0	8.5	9.0	10.0	11.5	12.5	14.0	16.0	18.0	20.0	130
140	7.5	8.5	9.5	10.5	11.5	13.0	14.5	16.5	18.5	20.5	22.5	140
150	9.0	10.0	11.0	12.0	13.0	15.0	17.0	19.0	21.5	23.5	26.0	150
160	10.0	11.0	12.5	13.5	15.0	17.0	19.0	21.5	24.0	26.5	30.0	160
170	11.5	12.5	14.0	15.0	17.0	19.5	21.5	24.0	27.5	30.5	34.0	170
180	12.5	14.0	15.5	17.0	19.0	22.0	24.0	27.0	30.5	34.0	38.0	180

Stringing Sags for No. 12 AWG and No. 10 AWG, High Strength, 40% Conductivity Copper-Covered Steel Wire

Medium and Light Loading Districts

Short Spans

Span Length (Feet)	Temperature - Degrees Fahrenheit											Span Length (Feet)
	20 °	30 °	40 °	50 °	60 °	70 °	80 °	90 °	100 °	110 °	120 °	
	Sag in Inches											
100	2.8	3.0	3.3	3.6	4.0	4.5	5.1	5.7	6.4	7.5	8.6	100
110	3.3	3.5	3.9	4.3	5.0	5.5	6.1	6.9	7.7	8.8	10.0	110
120	3.9	4.2	4.7	5.1	6.0	6.5	7.3	8.1	9.0	10.2	11.5	120
130	4.6	5.0	5.6	6.1	7.0	7.6	8.5	9.4	10.4	11.6	13.1	130
140	5.5	5.9	6.5	7.1	8.0	8.8	9.7	10.8	11.8	13.2	14.8	140
150	6.4	6.8	7.5	8.2	9.0	10.0	11.0	12.1	13.4	14.9	16.4	150
160	7.3	7.8	8.6	9.4	10.5	11.3	12.4	13.7	15.0	16.5	18.2	160
170	8.3	8.9	9.8	10.7	11.5	12.7	13.9	15.3	16.7	18.3	20.0	170
180	9.4	10.0	11.0	12.0	13.0	14.2	15.4	17.0	18.5	20.1	22.0	180
190	10.5	11.3	12.4	13.4	14.5	15.8	17.0	18.7	20.3	22.0	24.0	190
200	11.6	12.6	13.7	14.8	16.0	17.4	18.9	20.6	22.1	24.0	26.0	200
210	12.9	13.8	15.1	16.2	17.5	19.2	20.6	22.4	24.1	26.1	28.0	210
220	14.2	15.2	16.6	17.9	19.5	21.0	22.4	24.4	26.2	28.2	30.2	220
230	15.6	16.7	18.2	19.5	21.0	22.8	23.4	26.4	28.4	30.4	32.5	230
240	17.0	18.3	19.9	21.3	23.0	24.8	26.5	28.5	30.6	32.7	34.9	240
250	18.6	19.9	21.6	23.1	25.0	26.9	28.8	30.7	32.8	35.1	37.3	250
260	20.2	21.6	23.4	25.1	27.0	29.0	31.0	33.0	35.0	37.5	39.8	260
270	22.0	23.4	25.4	27.2	29.0	31.1	33.2	35.2	37.4	40.0	42.4	270
280	23.8	25.4	27.3	29.4	31.5	33.4	35.6	37.7	40.0	42.6	45.1	280
290	25.6	27.3	29.4	31.6	33.5	35.8	38.2	40.2	42.4	45.3	47.8	290
300	27.6	29.4	31.6	34.0	36.0	38.4	40.7	42.9	45.0	48.0	50.5	300
310	29.6	31.6	33.8	36.2	38.5	40.8	43.3	45.5	47.8	50.7	53.3	310
320	31.8	34.0	36.2	38.6	41.0	43.4	46.0	48.4	50.6	53.6	56.1	320
330	34.0	36.2	38.6	41.2	43.5	46.0	48.8	51.1	53.4	56.4	59.2	330
340	36.4	38.8	41.2	43.8	46.5	48.8	51.6	54.0	56.2	59.4	62.0	340
350	39.0	41.3	43.8	46.4	49.0	51.4	54.4	57.1	59.2	62.4	65.2	350

Stringing Sags for No. 10 AWG, High Strength, 40% Conductivity Copper-Covered Steel Wire

Medium and Light Loading Districts

Medium Spans

Span Length (Feet)	Temperature - Degrees Fahrenheit											Span Length (Feet)
	20	30	40	50	60	70	80	90	100	110	120	
	Sag in Inches											
350	39.0	41.3	43.8	46.4	49.0	51.4	54.4	57.1	59.2	62.4	65.2	350
375	45.4	48.0	50.7	53.5	56.2	59.0	61.9	64.4	66.8	69.8	73.0	375
400	52.6	55.2	58.3	61.2	64.0	67.0	70.1	72.7	76.0	78.5	81.6	400
425	60.1	63.1	66.5	69.4	72.5	75.5	78.8	81.3	84.3	87.5	90.7	425
450	68.4	71.8	75.4	78.5	81.6	84.8	88.0	91.0	94.1	97.0	100.0	450
475	77.3	81.0	84.6	88.0	91.0	94.5	97.6	100.6	104.0	106.5	110.0	475
500	86.4	90.2	94.0	97.3	100.0	104.0	107.4	110.6	114.4	117.1	120.4	500

Stringing Sags for No. 8 AWG, High Strength, 40% Conductivity Copper-Covered Steel Wire

Medium and Light Loading Districts

Long Spans

Span Length (Feet)	Temperature - Degrees Fahrenheit											Span Length (Feet)
	20	30	40	50	60	70	80	90	100	110	120	
	Sag in Feet											
500	3.8	3.9	4.1	4.3	4.6	4.8	5.0	5.2	5.5	5.7	6.0	500
550	4.9	5.1	5.3	5.5	5.8	6.1	6.3	6.6	6.9	7.2	7.5	550
600	7.6	7.9	8.2	8.5	8.8	9.1	9.5	9.8	10.1	10.5	10.8	600
650	11.2	11.5	11.9	12.2	12.6	12.9	13.2	13.6	13.9	14.2	14.5	650
700	15.3	15.7	16.0	16.4	16.7	17.0	17.3	17.6	18.0	18.3	18.6	700
750	19.8	20.1	20.4	20.8	21.1	21.4	21.7	22.0	22.4	22.7	23.0	750
800	24.6	24.9	25.2	25.5	25.9	26.2	26.5	26.8	27.1	27.4	27.6	800
850	29.6	29.9	30.2	30.5	30.8	31.1	31.4	31.7	32.0	32.3	32.6	850
900	35.0	35.3	35.6	35.9	36.2	36.5	36.8	37.1	37.3	37.6	37.9	900
950	40.7	41.0	41.3	41.6	41.9	42.2	42.5	42.7	43.0	43.3	43.6	950
1000	46.7	47.0	47.2	47.5	47.8	48.1	48.3	48.6	48.9	49.2	49.4	1000
1100	59.6	59.9	60.1	60.4	60.7	60.9	61.2	61.5	61.7	62.0	62.3	1100
1200	74.0	74.2	74.5	74.8	75.0	75.3	75.5	75.8	76.0	76.3	76.6	1200
1300	89.8	90.0	90.3	90.6	90.8	91.1	91.3	91.6	91.8	92.1	92.3	1300
1400	107.2	107.4	107.7	107.9	108.2	108.4	108.7	108.9	109.2	109.4	109.6	1400
1500	126.2	126.5	126.7	127.0	127.2	127.4	127.7	127.9	128.2	128.4	128.6	1500

Stringing Sags for No. 12 and No. 10 AWG, High Strength, 40% Conductivity Copper-Covered Steel Wire

Heavy Loading District

Short Spans

Span Length (Feet)	Temperature - Degrees Fahrenheit											Span Length (Feet)
	20	30	40	50	60	70	80	90	100	110	120	
	Sag in Inches											
80	2.3	2.5	2.8	3.2	3.7	4.3	5.0	5.9	6.8	7.8	8.9	80
90	2.8	3.2	3.6	4.0	4.7	5.3	6.2	7.2	8.2	9.4	10.5	90
100	3.6	4.0	4.5	5.1	5.8	6.6	7.6	8.7	9.9	11.1	12.3	100
110	4.4	4.9	5.5	6.2	7.0	7.9	9.0	10.2	11.3	12.7	14.0	110
120	5.2	5.9	6.6	7.4	8.2	9.3	10.6	11.8	13.1	14.5	15.8	120
130	6.3	7.0	7.8	8.8	9.8	10.8	12.2	13.6	15.0	16.4	17.8	130
140	7.4	8.2	9.1	10.2	11.2	12.5	14.0	15.5	16.9	18.3	19.9	140
150	8.7	9.5	10.6	11.7	13.0	14.4	16.0	17.4	19.0	20.5	21.9	150
160	10.0	11.0	12.0	13.4	14.6	16.2	17.8	19.4	21.0	22.6	24.4	160
170	11.5	12.5	13.7	15.2	16.7	18.2	20.0	21.6	23.3	25.0	26.6	170
180	13.0	14.2	15.5	17.1	18.7	20.3	22.0	23.8	25.6	27.3	29.2	180
190	14.6	16.0	17.4	19.2	20.8	22.5	24.4	26.2	28.1	29.8	31.8	190
200	16.4	18.0	19.4	21.3	23.0	24.9	26.8	28.6	30.6	32.4	34.5	200

Stringing Sags for No. 10 and No. 8 AWG, High Strength, 40% Conductivity Copper-Covered Steel Wire

Heavy Loading District

Short Spans

Span Length (Feet)	Temperature - Degrees Fahrenheit											Span Length (Feet)
	20	30	40	50	60	70	80	90	100	110	120	
	Sag in Inches											
200	16.4	18.0	19.4	21.3	23.0	24.9	26.8	28.6	30.6	32.4	34.5	200
210	18.6	20.2	21.8	23.5	25.4	27.3	29.3	31.3	33.2	35.2	37.0	210
220	20.7	22.4	24.0	25.9	27.8	29.8	32.0	34.0	36.0	38.0	39.8	220
230	23.0	24.7	26.5	28.4	30.4	32.6	34.7	36.9	38.8	41.0	42.8	230
240	25.4	27.2	29.0	31.0	33.0	35.4	37.6	39.8	41.8	44.0	46.0	240
250	27.8	29.7	31.6	33.8	36.0	38.2	40.6	42.8	44.9	47.0	49.0	250
260	30.4	32.5	34.5	36.7	38.8	41.2	43.6	45.8	48.1	50.2	52.4	260
270	33.2	35.4	37.4	39.8	42.0	44.4	46.8	49.1	51.3	53.6	55.8	270
280	36.0	38.3	40.5	42.8	45.1	47.6	50.0	52.4	54.6	56.8	59.4	280
290	39.0	41.4	43.7	46.0	48.4	50.9	53.2	55.6	58.0	60.3	63.0	290

Stringing Sags for No. 8 AWG, High Strength, 40% Conductivity Copper-Covered Steel Wire

Heavy Loading District

Medium Spans

Span Length (Feet)	Temperature - Degrees Fahrenheit											Span Length (Feet)
	20	30	40	50	60	70	80	90	100	110	120	
	Sags in Inches											
300	42.0	44.6	47.1	49.5	51.9	54.2	56.7	59.1	61.5	63.9	66.1	300
310	45.5	48.0	50.3	53.0	55.5	57.7	60.3	62.7	65.1	67.5	69.6	310
320	48.8	51.4	53.8	56.5	59.0	61.4	64.0	66.4	68.9	71.3	73.0	320
330	52.4	55.0	57.5	60.2	62.7	65.2	67.7	70.3	72.8	75.1	77.4	330
340	56.0	58.7	61.3	64.0	66.6	69.1	71.6	74.3	76.8	79.3	81.5	340
350	59.9	62.6	65.2	68.0	70.8	73.4	75.9	78.5	81.0	83.5	85.7	350

Stringing Sags for No. 8 AWG, High Strength, 40% Conductivity Copper-Covered Steel Wire

Heavy Loading District

Long Spans

Span Length (Feet)	Temperature - Degrees Fahrenheit											Span Length (Feet)
	20	30	40	50	60	70	80	90	100	110	120	
	Sags in Feet											
350	5.0	5.2	5.4	5.7	5.9	6.1	6.3	6.5	6.7	7.0	7.2	350
400	11.0	11.2	11.4	11.5	11.7	11.9	12.0	12.2	12.3	12.5	12.7	400
500	21.8	22.0	22.1	22.2	22.4	22.5	22.7	22.9	23.1	23.3	23.5	500
600	35.1	35.3	35.4	35.5	35.6	35.7	35.8	36.0	36.1	36.2	36.4	600
700	51.0	51.1	51.2	51.3	51.5	51.6	51.8	51.9	52.0	52.1	52.3	700
800	70.1	70.2	70.3	70.4	70.6	70.7	70.9	71.0	71.1	71.2	71.4	800

Stringing Sags for
No. 6 AWG, High Strength, 40% Conductivity
Copper-Covered Steel Wire

Heavy Loading District

Long Spans

Span Length (Feet)	Temperature - Degrees Fahrenheit										
	20	30	40	50	60	70	80	90	100	110	120
800	44.6	44.8	44.9	45.1	45.3	45.5	45.7	45.9	46.1	46.3	46.5
900	59.3	59.5	59.7	59.8	60.0	60.2	60.4	60.6	60.8	60.9	61.1
1000	76.1	76.3	76.5	76.7	76.8	77.0	77.2	77.4	77.6	77.7	77.9
1100	95.3	95.4	95.6	95.8	96.0	96.1	96.3	96.5	96.6	96.8	97.0
1200	116.9	117.1	117.3	117.4	117.6	117.8	117.9	118.1	118.3	118.5	118.6
1300	141.4	141.6	141.8	141.9	142.1	142.3	142.4	142.6	142.8	142.9	143.1
1400	169.2	169.3	169.5	169.7	169.8	170.0	170.2	170.3	170.5	170.6	170.8
1500	200.7	200.9	201.1	201.2	201.4	201.5	201.7	201.9	202.0	202.1	202.3

129. Transposition

Transposing of line wires in a metallic circuit is a necessity to its proper functioning. In addition, transposing wires, where they are parallel with other telephone circuits, power transmission wires or just wires is necessary to prevent the accumulation of noise on the circuit inducted from these other wires. Where other wires are parallel with the circuit wires, not necessarily close, the circuit wires are regarded as an exposed circuit or wire system. For such a line or circuit four types of transposition systems have been designed to overcome this inducted interference and at the same time provide the necessary transposing of metallic circuit wires regardless of exposure.

These four systems are designated E, L, R and R1 and have been selected as the standard for the Forest Service. The transposition schemes appear in the appendix.

The E, L, and R transposition systems require considerable care in their location and are mostly adaptable to circuits constructed on crossarms and to all circuits which are to be or may be a part of a phantom circuit.

The R1, transposition system provides the necessary transposing of the circuit wires and adequately handles the exposure factor. In addition, it provides, without the cutting and dead ending of conductor wires, point type transposition, it is simple, readily understandable, requires no great experience

in replacing, if conductor wires are broken, and eliminates high level transposition engineering. The R1 system is fully explained in the appendix.

The advantages for the R1 system are so many that it has been adopted as a standard for all metallic circuits constructed or reconstructed in the future, except those to be used as and those which may become a part of a phantom circuit.

The E, L, and R transposition systems are made up of four transposition types, all of which are clearly shown in the transposition schemes in the appendix. Some circuits may have all four types where another may have only one or two. Line interference together with its frequency and length, plus the total length of the circuit, governs the selection of transposition types. Each transposition system, except R1, has a working length called a section which must not be increased more than 2% but may be decreased as much as is desired but not below the working length of the next shortest transposition section, provided the required number of transposition poles are available. The tabulation below indicates transposition sections, working length of each, and the number of transposition poles in each. There are many complex problems involved in designing transposition schemes for a designated circuit. For this reason such designs should be developed in the Regional office from data secured by the Communications Engineer.

Transposition Section	Working length in feet	Number of Transposition Poles
E	41,600	32
L	20,800	16
R	2,600	4

The most practical method of transposing wires, is to "throw" the transpositions at the time the wire is reeled out. This step requires attention to the details of the transposition plan for the circuit. Each transposition point and type should be designated on the ground in advance of the wire stringing. A "transposition running board" should be used in stringing the wires, small board for two wires in R1 system, large board for four wires regardless of transposition system.

The R1 system provided for every other pole to be a transposition pole except, where two or more circuits are carried on the same pole then the transpositions should be staggered on any two adjacent circuits thus making every pole a transposition pole for at least one of the circuits, whether bracket or crossarm construction. The length of the span has no appreciable effect on the

transpositions, as long as the every other pole scheme is followed. The transpositions should be made on Whitall Tatum #15 or Hemingray #53 or similar double groove, glass insulators mounted on a tandem transposition bracket assembly or crossarm. See page 146.

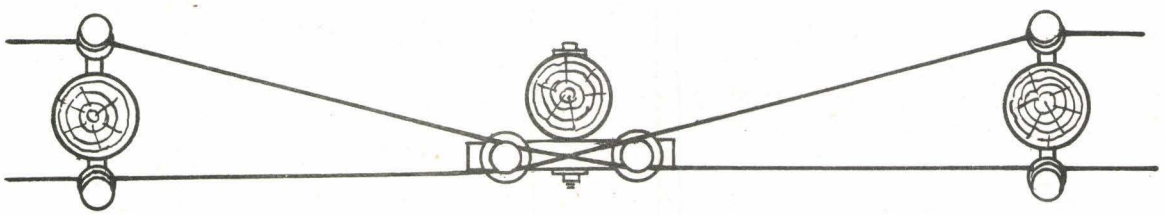
In bracket construction the top pair of wires will be transposed as 5 and 6 and the bottom pair as 15 and 16. This method is advantageous to later replacing the bracket construction with crossarms. Phantom transpositions in bracket-line construction are transposed as the 5-6 - 15-16 group.

For 6-pin cross-arm construction, the initial pair should be put on pins 5 and 6 and transposed as such. For phantom groups on 6-pin crossarms, use pin positions 3-4-5 and 6 and transpose in accordance with that scheme. Under some conditions, pins 5-6, 7-8 may be more suitable for phantom transpositions.

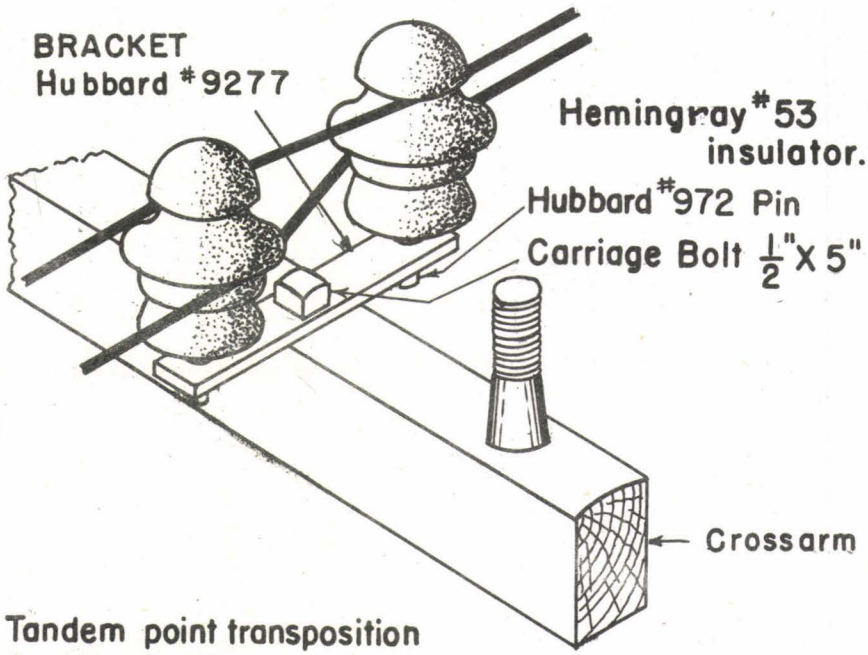
For 10-pin arms, phantom groups should be transposed as 1-2, 3-4, and 7-8, 9-10. The pole pair, 5 and 6, may be phantomed with a bracket pair underneath the arm, but never with another pair on the same arm. Pin configuration for 6- and 10-pin crossarms is shown on page 314.

130. Transpositions R1

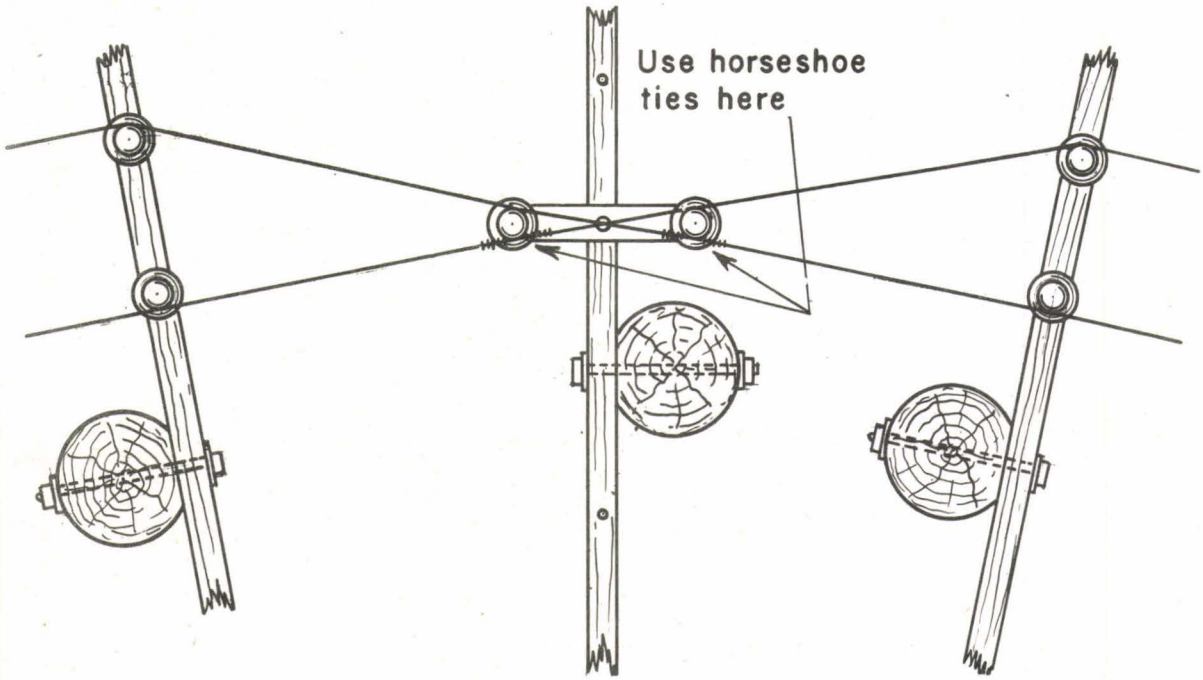
On a two wire bracket line in which spans average over 150 feet, transpose on the B transposition bracket in straight sections and at corners of 15 foot pull or less. At corners where the pull exceeds 15 feet, use a C tandem transposition bracket. Both B and C brackets will be mounted on an angle plate. See R1 bracket assembly page 98.



TRANSPOSITION R I.



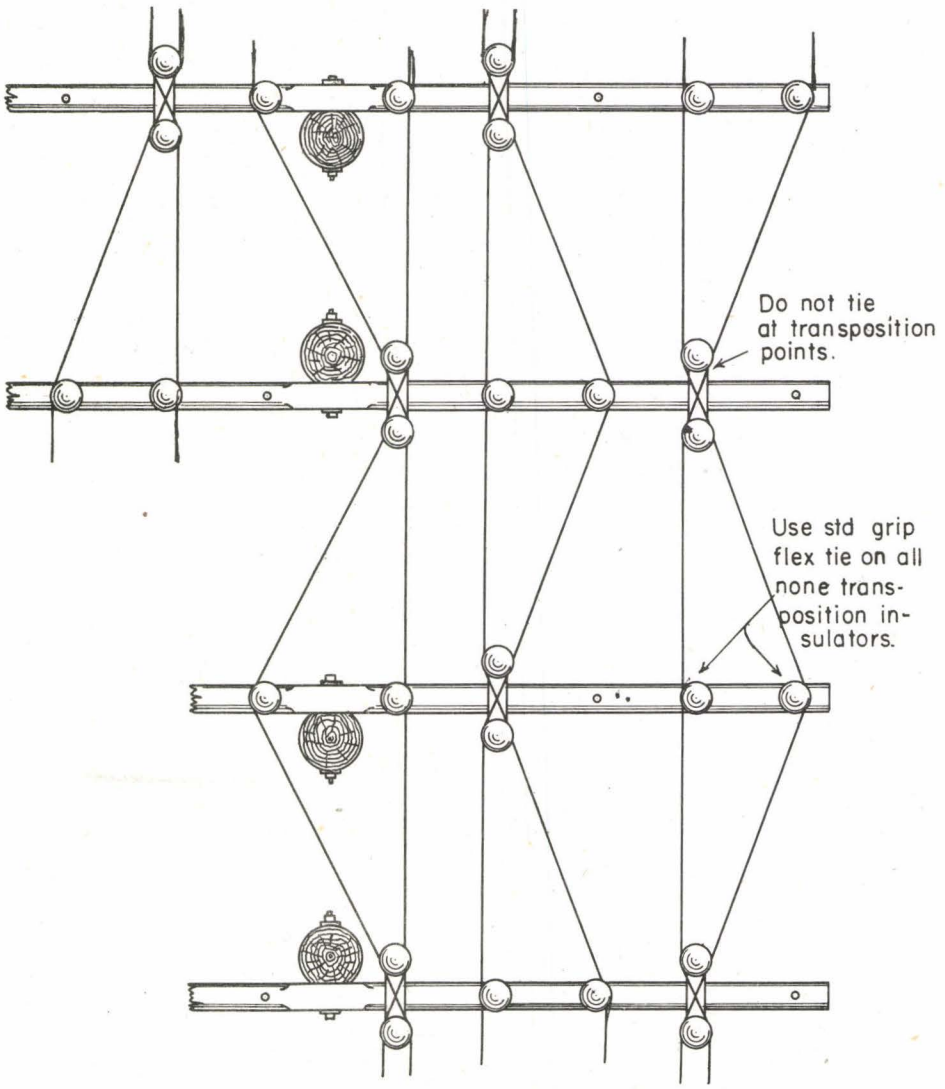
Tandem point transposition bracket for lines equipped with crossarms



LINE WIRE POSITION AT CORNERS R' TRANSPOSITION

The illustration below shows the positions on the insulators which the line wire should occupy in straight sections of line, both at the transposition brackets and at the non-transposed points. Notice that the wires are arranged so that the maximum practicable separation is provided between the line wires in the span by tying the wires at non-transposed points on the opposite sides of the insulators.

At corners however the wires at non-transposed points should be placed on the insulators so that it will pull against them. Use modified "horseshoe" tie on transposition insulators at all angles where the pull exceeds 25 feet.



LINE WIRE TRANSPOSITION
(RI Transposition)

Note Position of transpositions looking in direction of increasing numbers.

POLE HEAD
R I TRANSPOSITION PATTERN

131. Tying Rl transposed lines

The wires should be tied at all non-transposed points using the grip-flex reinforcing tie. These ties should be made at least one span in advance of mounting the transposition on tne brackets.

No ties are required at the tandem brackets, except:

(a) At corners where the pull exceeds 25 feet.

(b) At highway and railroad crossings, including those in straight sections of line.

(c) At corners where the pull exceeds 25 feet, tie each line wire once and at different insulators on the tandem bracket with a modified "horseshoe" tie. Use the insulator for tying that has the smaller amount of pull against it.

(d) At highway and railroad crossings tie each conductor at each insulator on the tandem bracket with a modified"horseshoe" tie.

(e) Be sure that the preceding transpositions are in place before tying non-transposed points.

132. Mounting Transpositions on Tandem Brackets

The line wires should be placed in the tandem insulator grooves at transposition positions after they have been tied-in at the next non-transposed positions. The right wire of the pair, looking toward the direction in which the circuit leads, should be placed in the bottom groove of the tandem insulators, and the left wire in the upper groove. The tandem transposition bracket should be free to swing and thereby adjust any inequalities of tensions in the two wires. The wires can usually be placed on the insulator without the use of tools, however at the heavier corners, it may be necessary to use wire grips to relieve the pressure thus allowing the wire to be placed properly in the grooves. If sag begins to accumulate, the condition should be corrected by either cutting in additional wire or cutting out excess, as required.

Tighten the carriage bolt supporting the bracket after the wires have been placed and sag conditions are satisfactory. (See Bracket Drawings Page 98.)

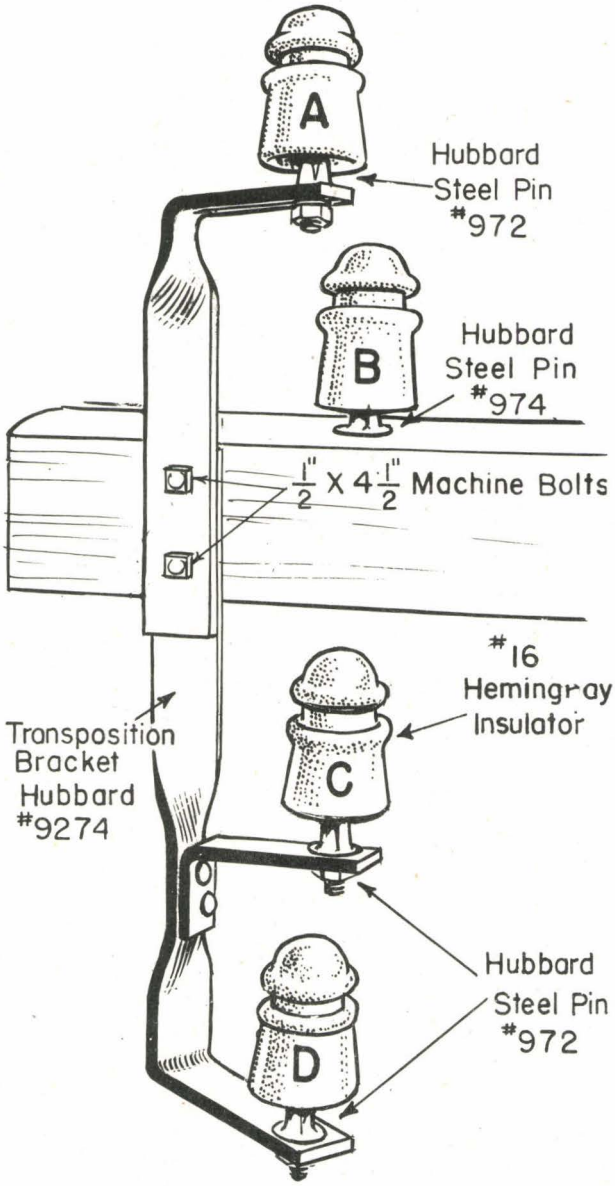
133. Transpositions, Phantom

Point transposition cannot be used for phantom transposed circuits, since a pole or crossarm fixture has not as yet been designed to serve this puspose. Therefore all phantom transpositions will be the roll type. For correct method and equipment used in throwing transpositions see page 152.

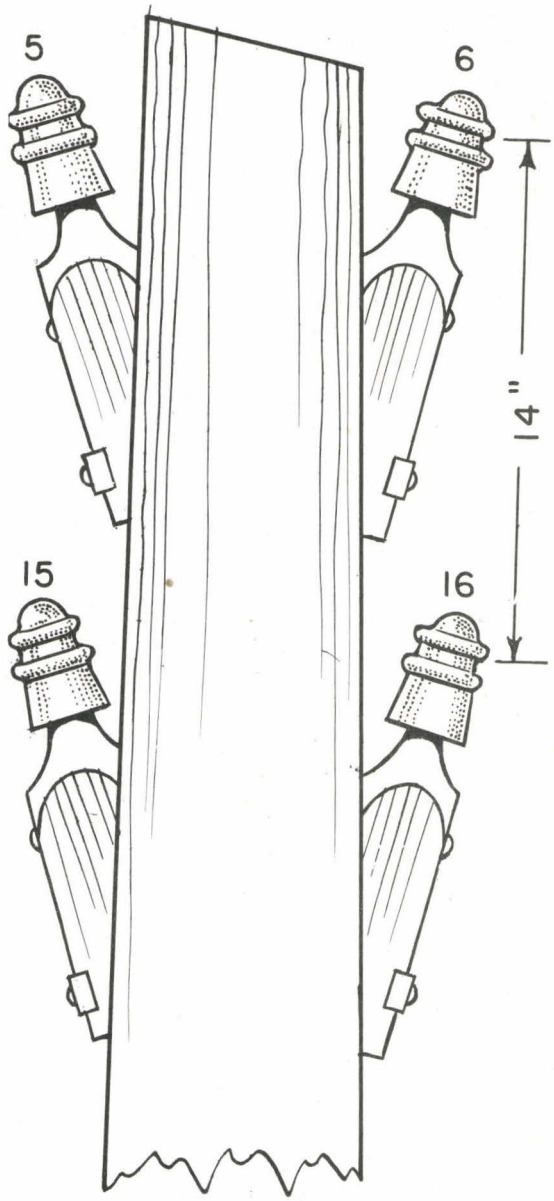
(a) Transposition Brackets

Phantom transpositions are made on a phantom transposition bracket designed for phantom circuits. Steel insulator pins will be used both on the bracket and on the crossarm. As a convenient means of reference, phantom bracket pins are designated by pin letters Phantom transposition circuits should be constructed to a high standard and maintained to the constructed standard. This is necessary to not only make the phantom circuit work but also to get full use of the wire circuits. Don't expect to have a satisfactory phantom circuit unless the transpositions are correctly made and at the right place and the wire is free of any interference such as brush or wind blown trash. It is necessary in phantom groups that all four wires be of equal material, gauge and state of deterioration. All transpositions, regardless of type or system should be made by rolling the wires clockwise looking in the direction of increasing pole numbers or where poles are not numbered from the exchange or switching station toward the end of the line for pole letters. See page 151.

(b) In pole bracket line construction the brackets at phantom transposition poles are placed opposite two on each side of the pole. The top brackets are numbered 5 and 6 and the bottom 15 and 16. See page 151.



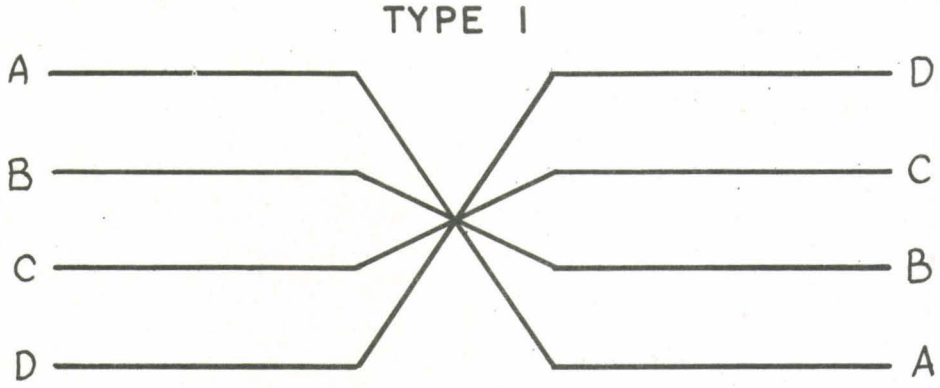
CROSSARM



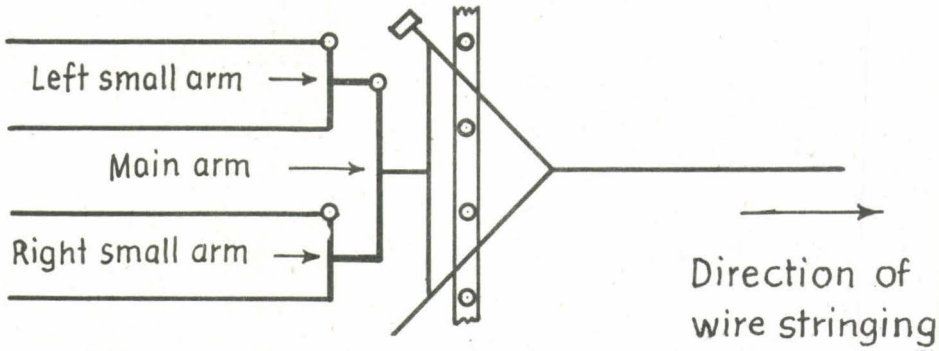
POLE BRACKET

PHANTOM BRACKET

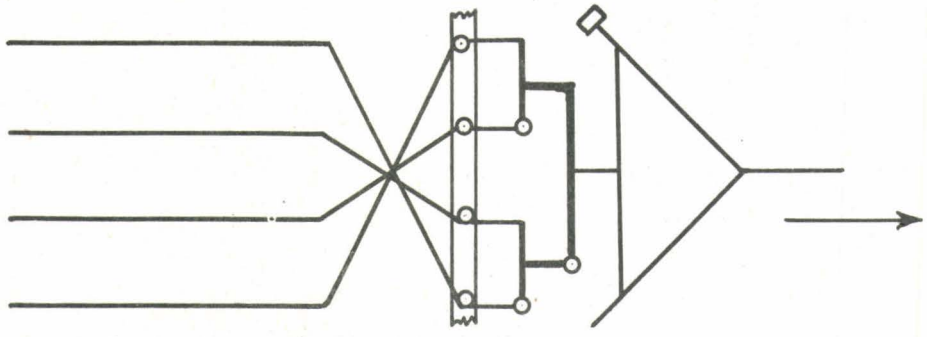
(b) Phantom Transpositions, Type 1



(1) At type 1 phantom transpositions the position of the wires is interchanged as shown above.



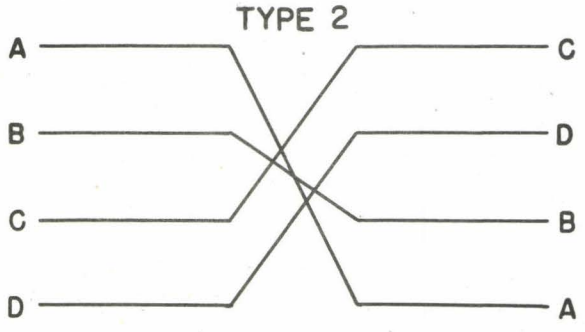
(2) Starting position of wires on transposition running board shown above.

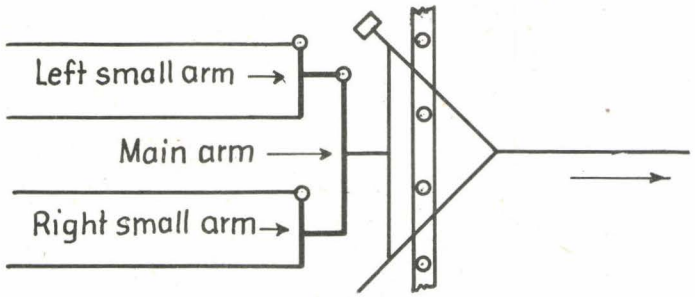


(3) Turn main arm clockwise (left over right) facing the direction in which the wires are being strung as shown above.

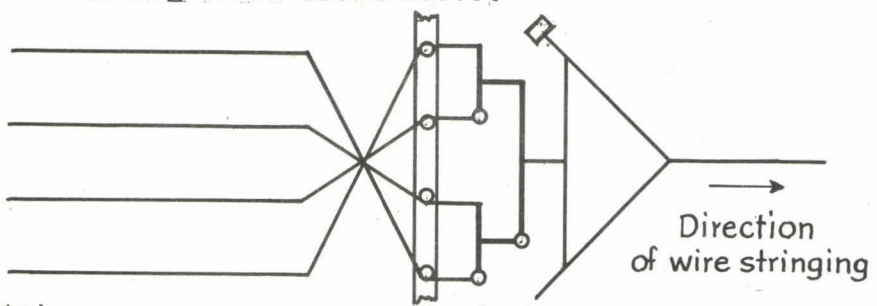
(c) Phantom Transpositions Type 2

(1) At type 2 phantom transpositions the position of the wires is interchanged as shown below.

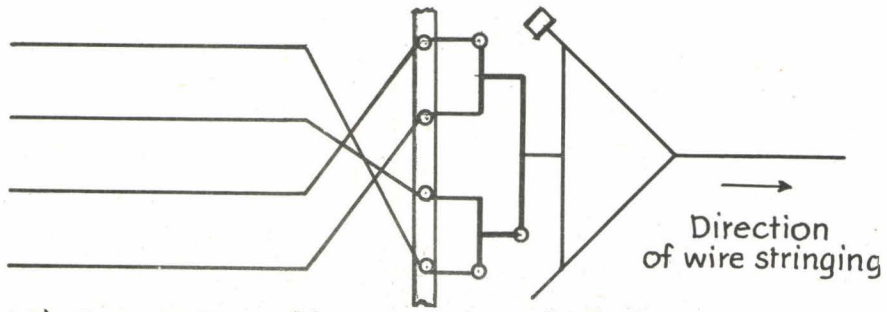




(2) Starting position of wires on transposition running board shown above.



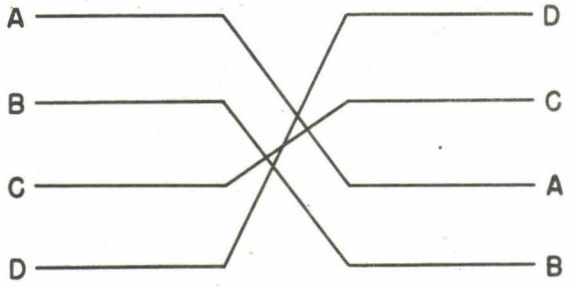
(3) Turn main arm clockwise (left over right) facing in the direction in which the wire is being strung as above.

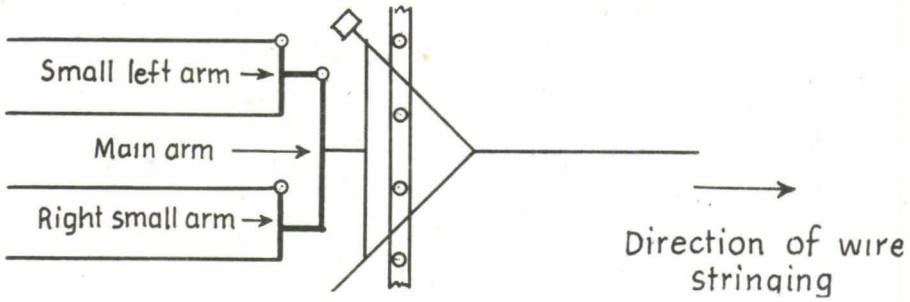


(4) Turn left smallarm counter-clockwise (right over left) facing in the direction in which the wire is being strung as above.

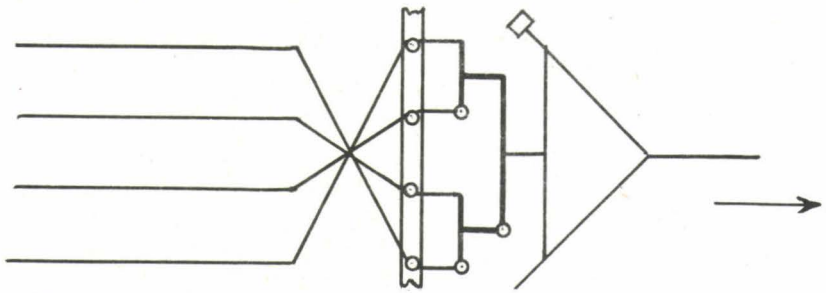
(d) Phantom Transpositions, Type 3

(1) At type 3 phantom transpositions the position of the wires is interchanged as shown below.

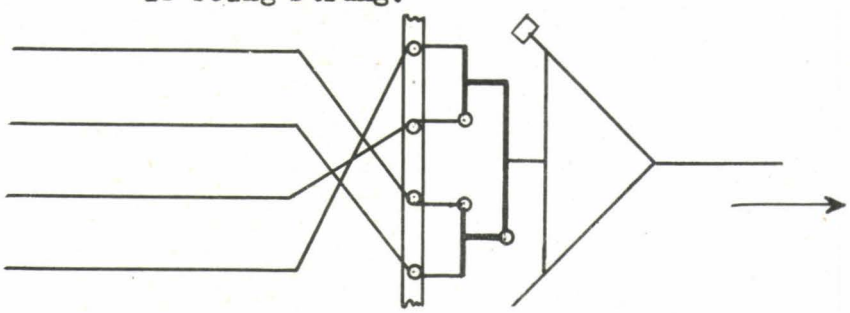




(2) starting position of wires on transposition running board.



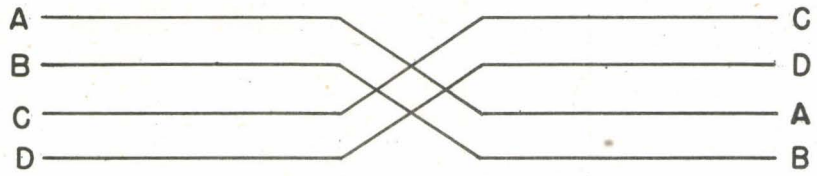
(3) Turn main arm clockwise (left over right) facing in the direction in which the wire is being strung.

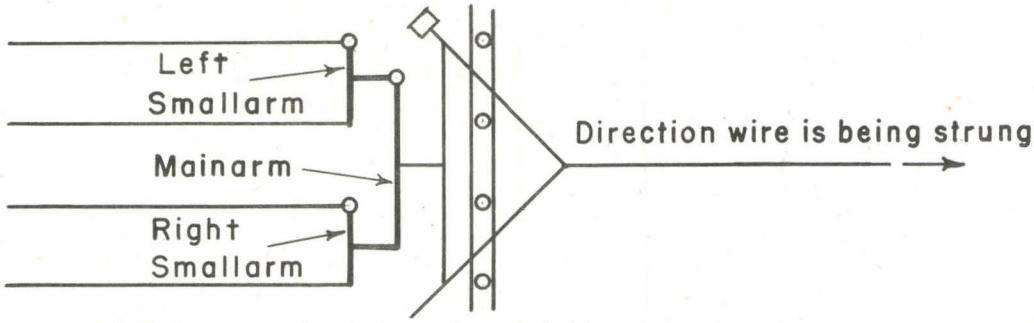


(4) Turn right small arm counter-clockwise (right over left) facing in the direction in which the wire is being strung.

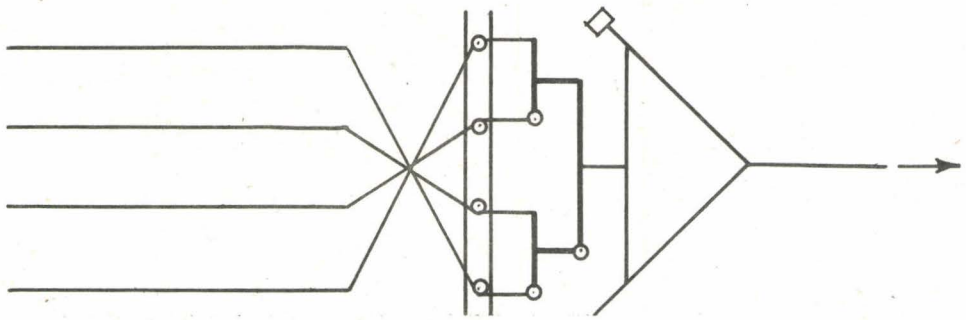
(e) Phantom Transpositions, Type 4

(1) At type 4 phantom transpositions the position of the wires is interchanged as shown below.

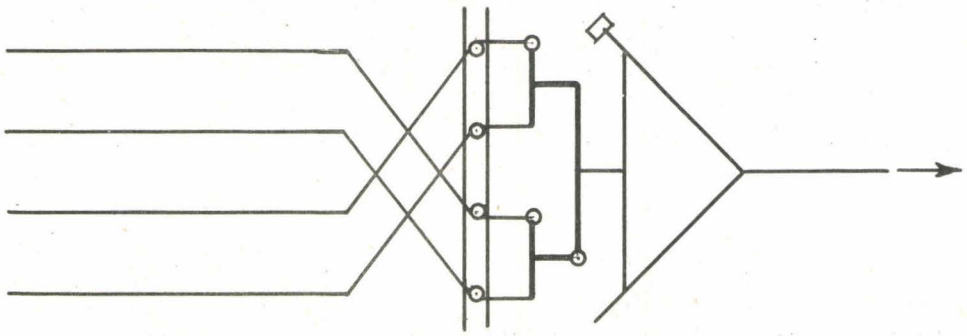




(2) Starting position of wires on the transposition running board.



(3) Turn main arm clockwise (left over right) facing the direction in which the wire is being strung as shown above.



(4) Turn both small arms counter-clockwise (right over left) facing in the direction in which the wire is being strung.

134. Tying Line Wires

In bracket-line construction, the line wire should be tied on the pole side of the insulator on straight sections, and on curves and corners so the pull will be against the insulator. See Fig. A.

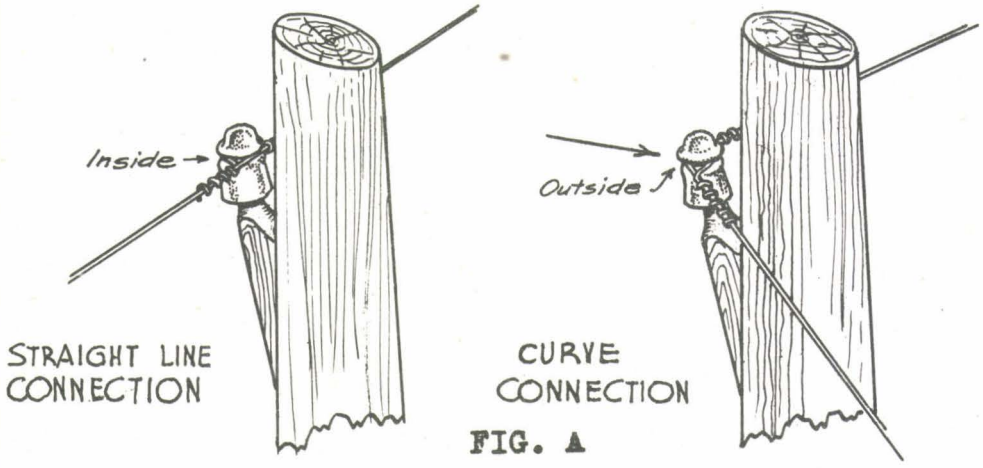


FIG. A

In crossarm line construction, the wire should be fastened as follows:

On straight sections attach wires on insulators. See Fig. B.

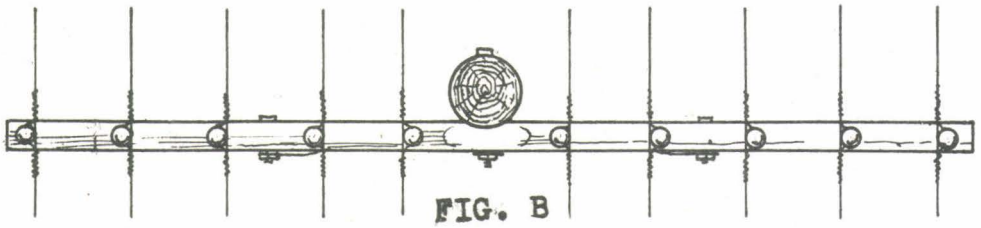


FIG. B

On corners attach wire on insulators so that the pull will be against the insulator. See Fig. C.

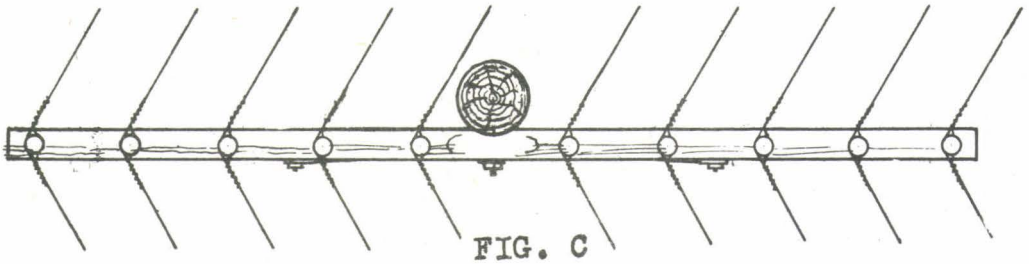


FIG. C

In areas of heavy loading and on slope of more than 20 per cent, top-groove insulators may be used except where the pull would be upward. The top-groove insulator allows the line wire to ride more freely under straight and down-pull strains.

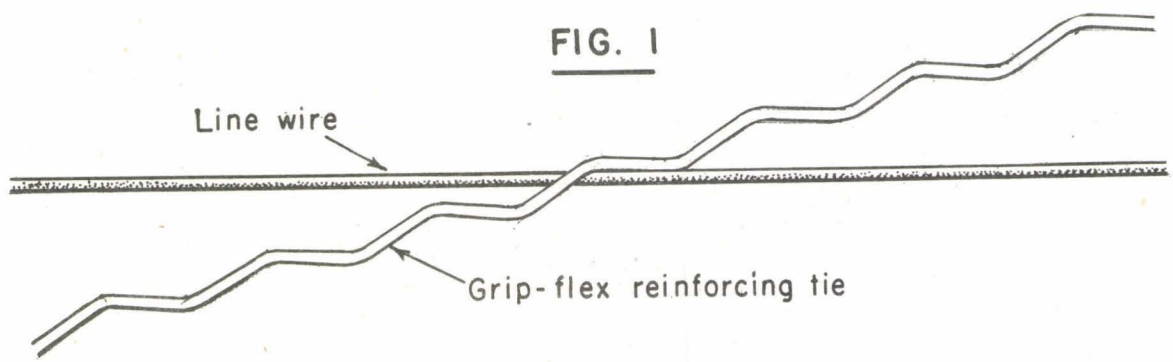
135. Ties, General

Ties to be used in tying line wire to insulators will vary with conditions and types of insulators. Since copper-covered steel wire will be used on all but tree lines each tie will be supported with the grip-flex #38 reinforcing tie regardless of its being a top or side groove insulator. Where galvanized iron wire is being tied the modified "horseshoe" tie will be used. Ready cut annealed copper-covered steel tie wire of the size recommended in the materials standard will be used for tying copper or copper-covered steel wire. Annealed #12 iron wire will be used for tying #9 iron wire.

(a) Ties, copper or copper-covered steel wire
(Top Groove Insulator)

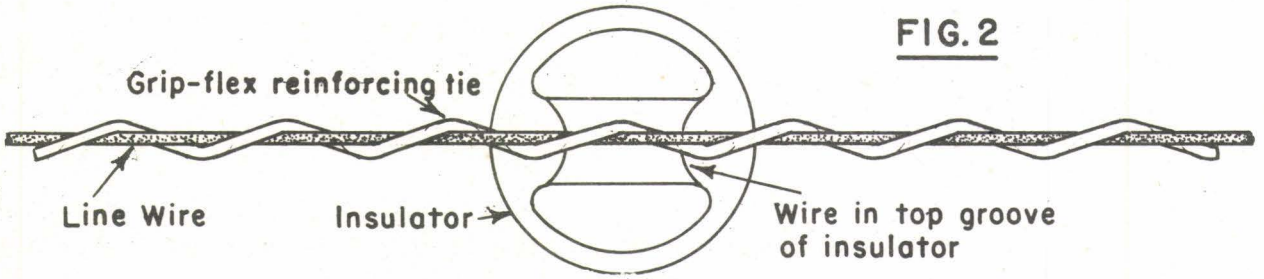
(1) Place grip-flex reinforcing tie on line wire as in figure (1), centering it at the insulator before starting to wrap it on the line wire.

FIG. 1



Place grip-flex reinforcing tie on line wire as in Fig. 1 above centering it at the insulator and wrap on line wire.

FIG. 2

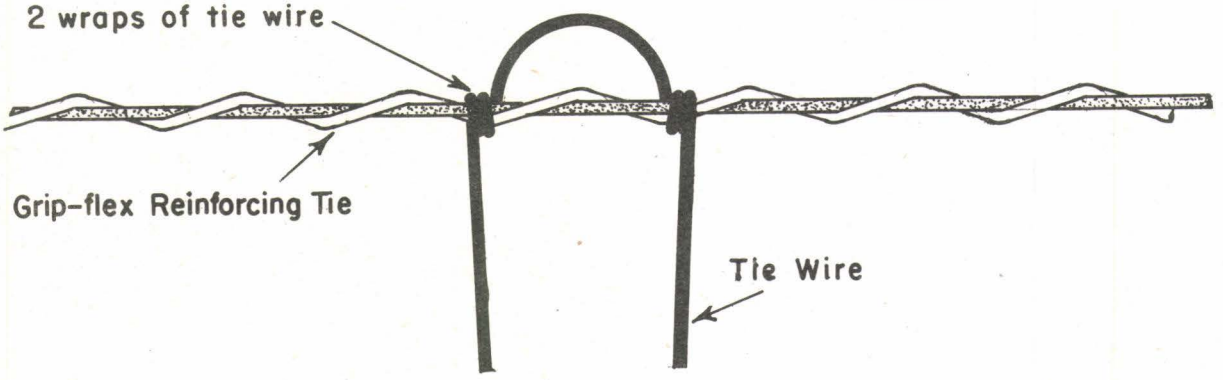


Place line wire, with grip-flex reinforcing the midpoint, in top groove of insulator as in Fig. 2 above.

FIG. 3

Place tie wire in top groove of insulator on opposite side as in Fig. 3 above.

FIG. 4



Make 2 wraps of tie wire around line wire. Bring ends from under side as in Fig. 4 above.

FIG. 5

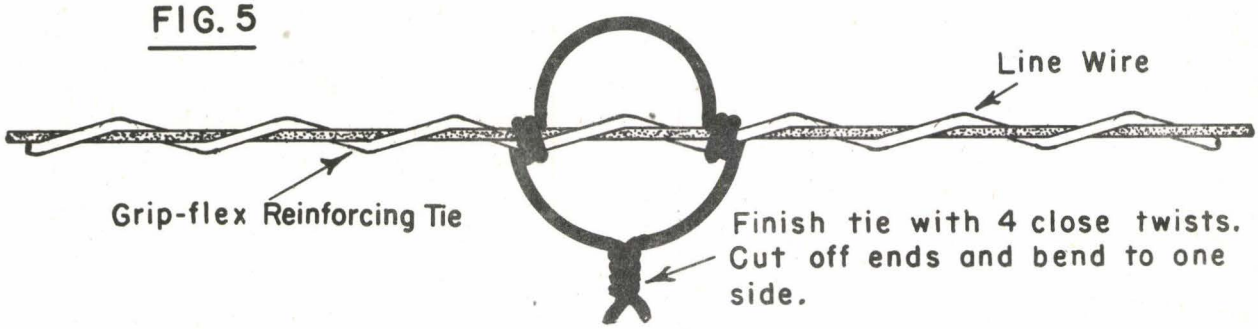
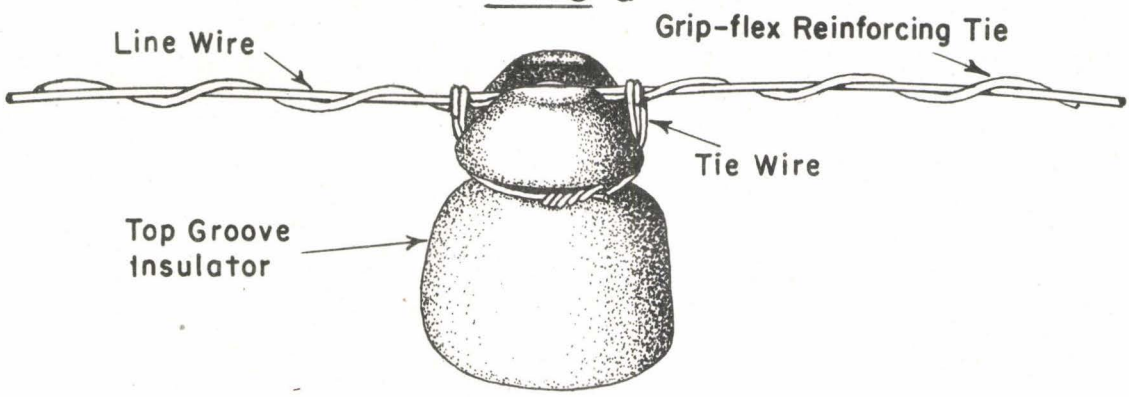


FIG. 5-a

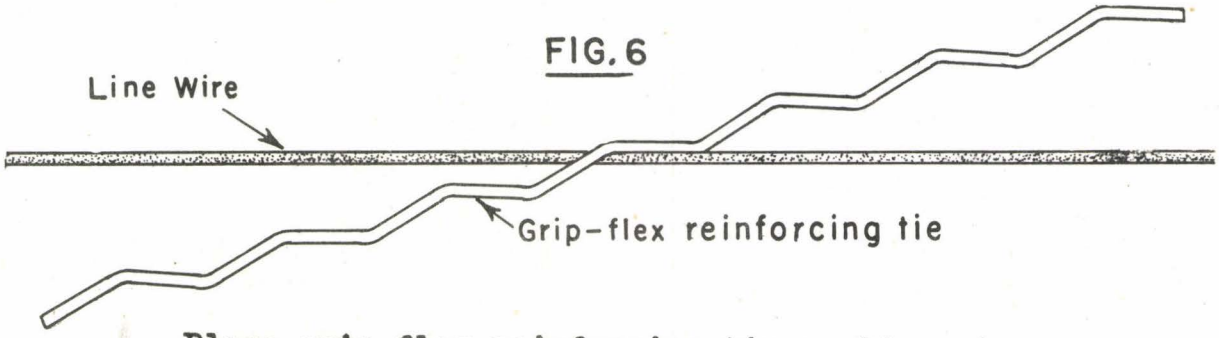


Complete tie with pigtail twist. Bend end to one side as in Fig. 5 and 5a above.

(b) Ties, Copper or Copper-covered steel wire (Side Groove Insulator)

For tying copper or copper-covered steel wire in side groove insulators, proceed as follows:

FIG. 6



Place grip-flex reinforcing tie on line wire as in Fig. 6 above centering it at the insulator and wrap on line wire.

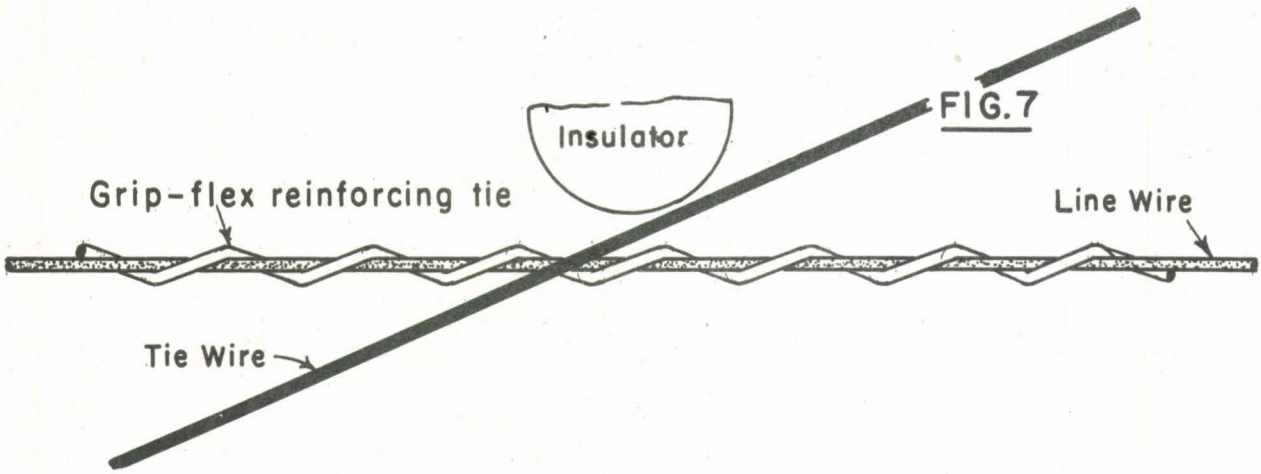


FIG.7

Place tie wire over line wire at midpoint of grip-flex reinforcing tie as in Fig. 7.

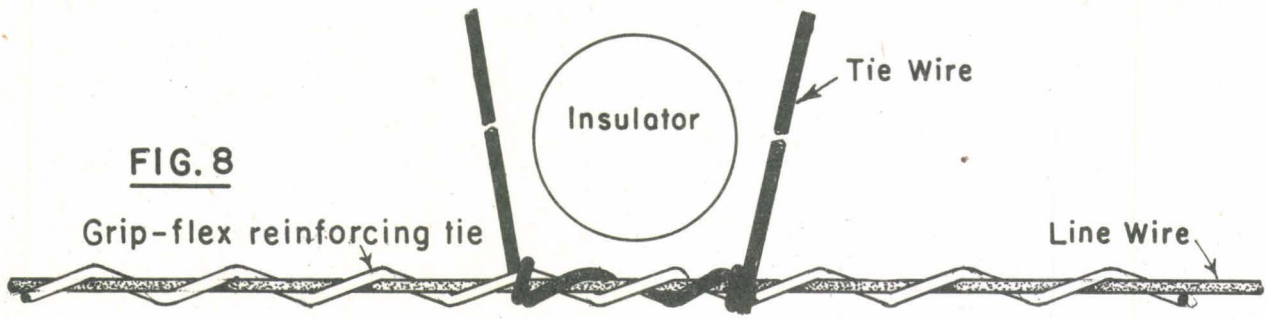


FIG. 8

Make 1-1/2 long wraps and 1-1/2 close wraps with tie wire around line wire and grip-flex reinforcing tie as in Fig. 8.

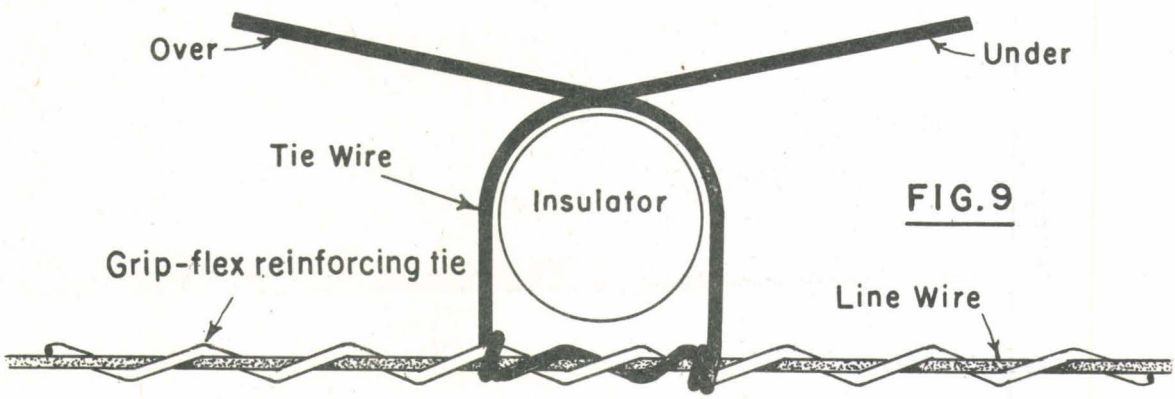
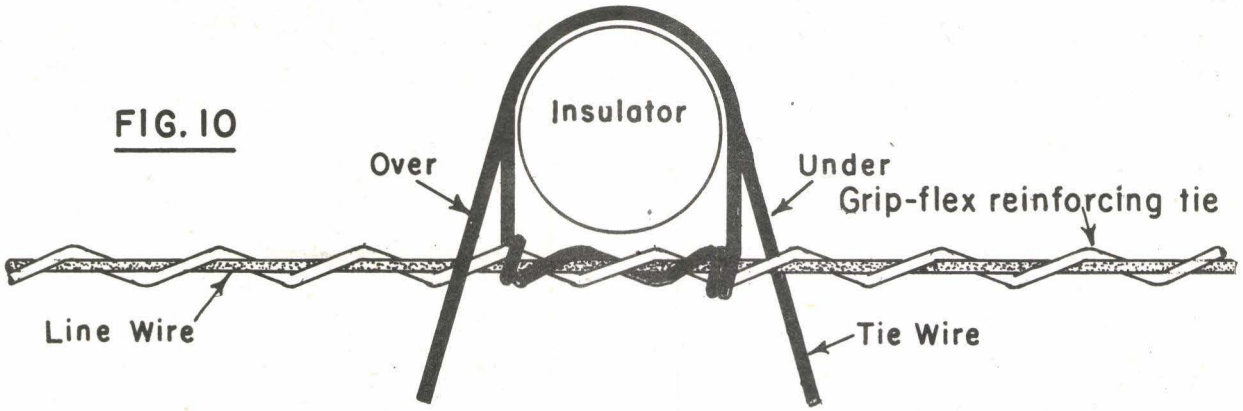


FIG.9

Place line wire in side groove of insulator and carry ends of tie wire around back side of insulator as in Fig. 9.

FIG. 10



Bring ends of tie wire to front of insulator with one under and one over line wire and complete tie as in Figs. 10, 11, and 12.

FIG. 11

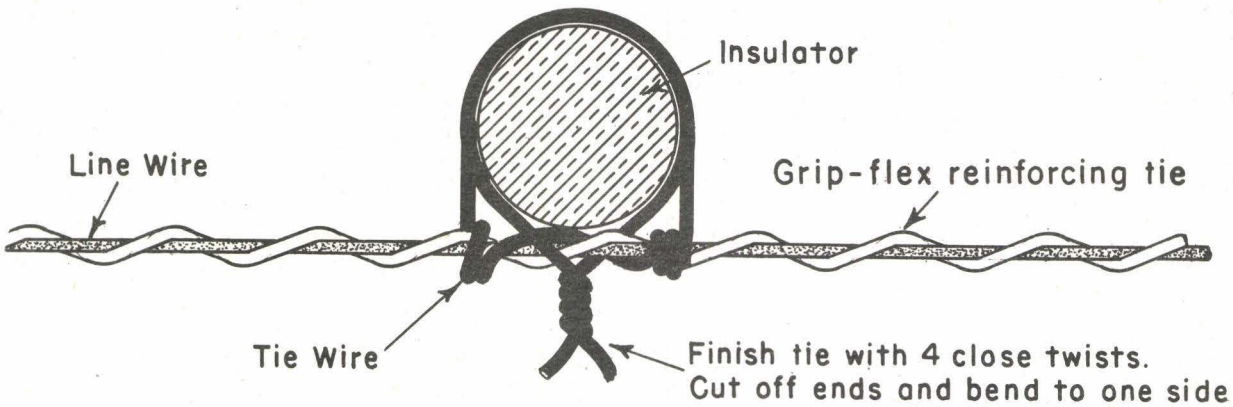
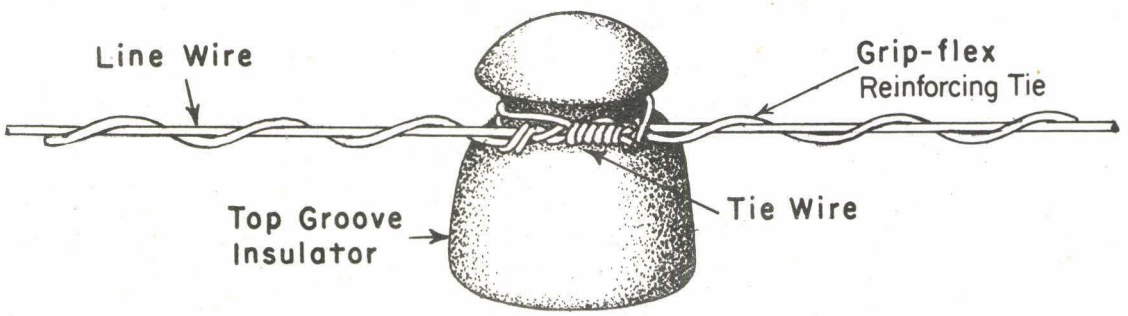


FIG. 12



(c) Ties, Iron wire, (top groove insulator)

For tying iron wire in top groove insulators, proceed as shown in Figs. 2,3,4, except that a grip-flex is not used, and finish as in Figs. 13, and 14.

FIG. 13

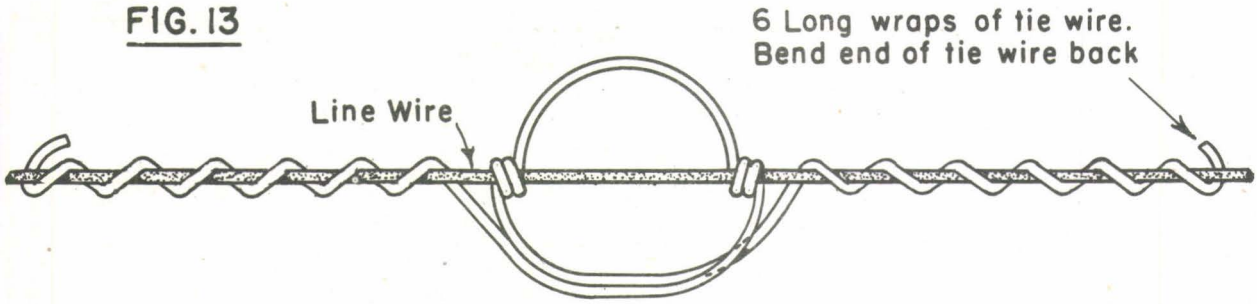
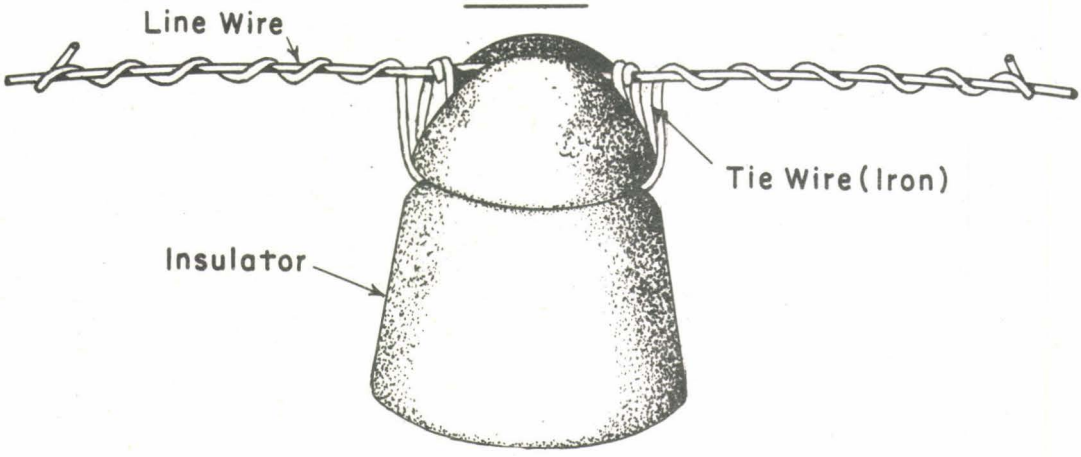


FIG. 14



(d) Ties, Iron wire, (side groove insulator)

For tying iron line wire inside groove insulators, use the modified "horseshoe" tie as shown in Fig. 15 below.

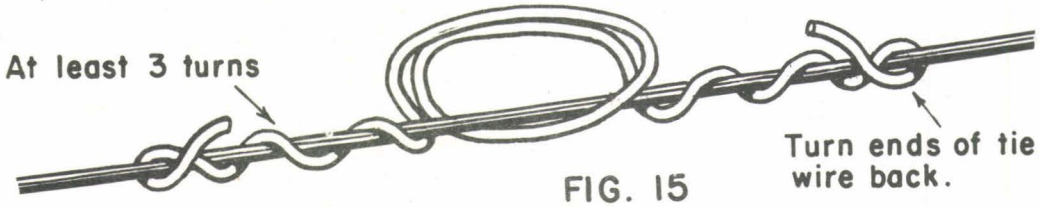
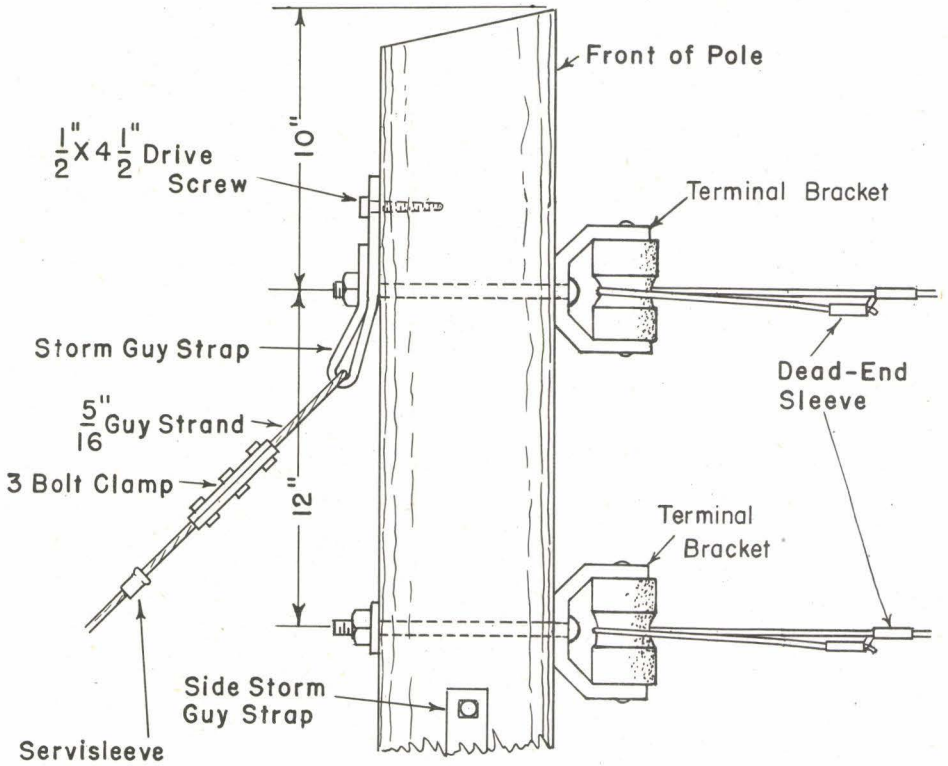


FIG. 15

136. Dead-ending Wires

Dead-ends are made at terminal poles, at long spans where extra strain is placed on both insulator and wire, and at some railroad and highway crossings.

The standard method for dead-ending wires on a pole-bracket line requires the use of a terminal bracket and insulator. The bracket is attached in accordance with drawing below.



DEAD-ENDS
POLE BRACKET LINE

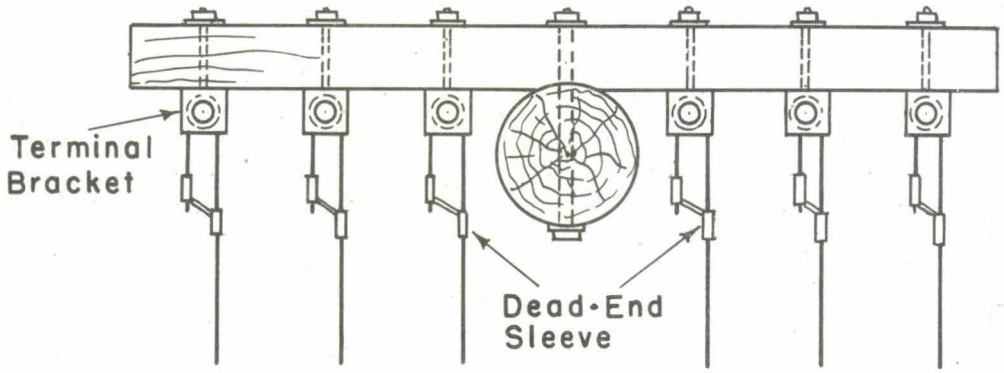
The standard method for dead-ending wires carried on crossarms requires the use of a dead-end arm 4¼" X 4½" X 6' with 16" spacing for the pole brackets and 6" spacing for all others. These arms will be attached to the pole on the opposite side from the pull. The wires will terminate on terminal brackets equipped with insulators. Dead-end or offset sleeves will be used for all dead-ends.

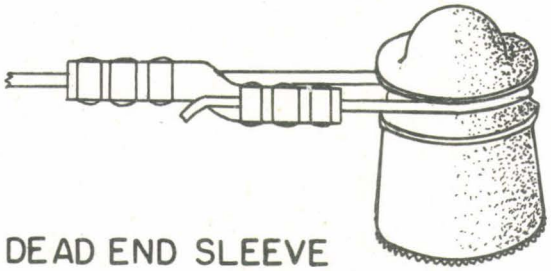
Where dead-ending on only one side of a crossarm, it will be necessary to guy the other side to the preceding pole to equalize the pull on the crossarm.

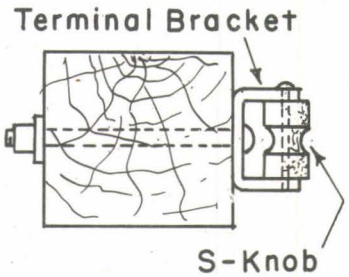
Place the offset (dead-end) sleeve on the wire before putting the end of the wire around the insulator, then after the wire has been shoved around the insulator place the end in the other sleeve, pull up and square in the regular manner, (See below). Leave sufficient pig tail to make a line splice if and when desired. Do not wrap the end of the wire either around the insulator or the line wire.

137. Dead-Ending Line Wire

Line wires can be terminated or dead-ended on pin type, spool, or strain insulators by using offset dead-end sleeves. These sleeves are compressed with the same tool used on the splicing sleeves.




DEAD END SLEEVE



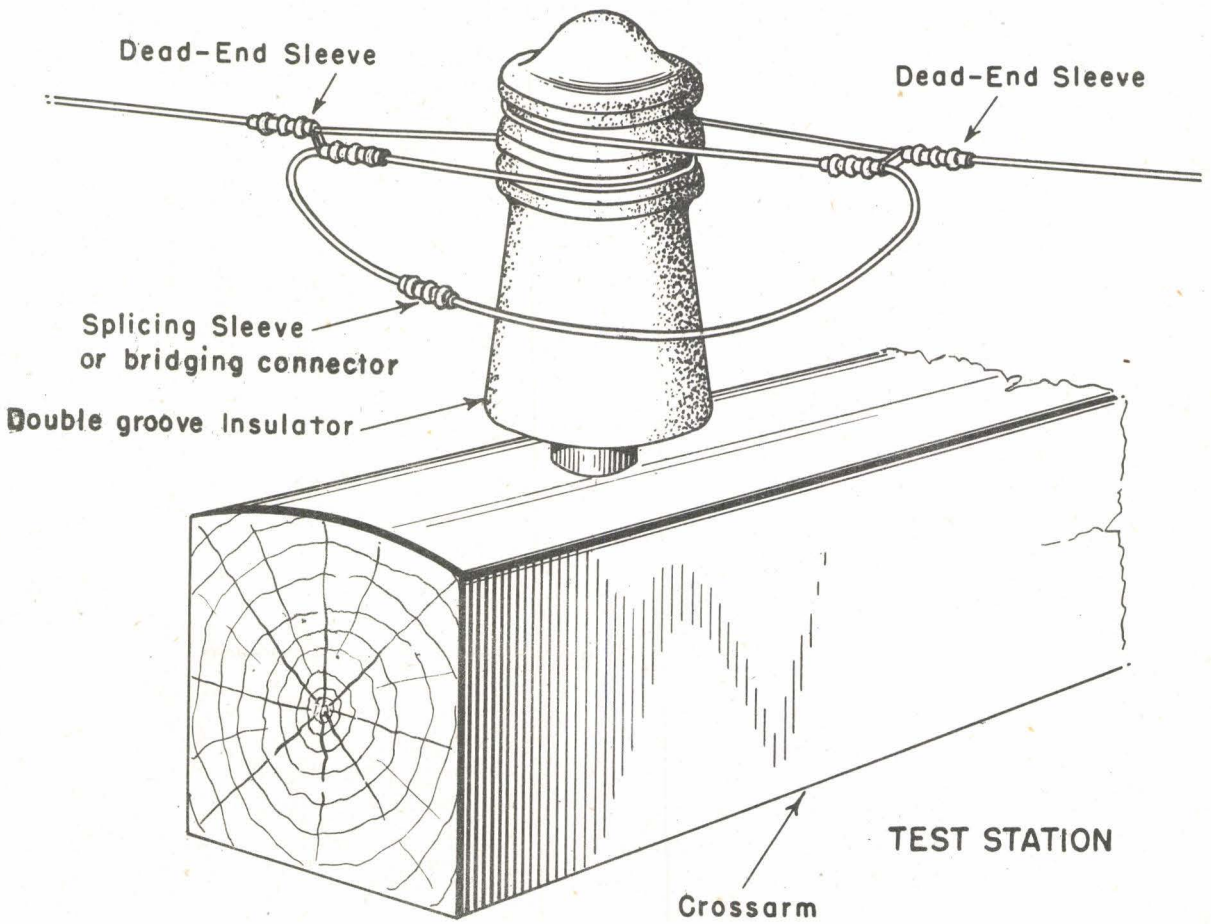
138. Test Stations

Test points along a metallic telephone line should be built in at the time of original construction. Such stations permit the making of tests on sections of the line without the necessity of cutting and resplicing line wires.

Test stations should be installed at neutral points (half or quarter points) in a transposition section. These points can be identified on the transposition diagrams.

Normal construction for such test stations will consist of dead-ends connected by means of bridging connectors or sleeves as illustrated.

Test station poles will usually be equipped with steps to facilitate climbing for line testing and inspection of connectors.



Use same method for pole and bracket line.
Splicing sleeves should be used at test stations, except where frequent tests (three months or more often) use a bridging connector.

139. Planning and Layout

Careful planning of aerial construction at terminal points, especially at Ranger and Guard stations will greatly lessen the many objections to this type of construction. From a communication service feature, this type of construction is by far more reliable and is not subjected to so many hazards as is underground construction. The planning should take full advantage of any screening possibilities and utilize the traveled and seen route.

The open wire plant is assumed to be terminated on a pole at the side or rear of the building area.

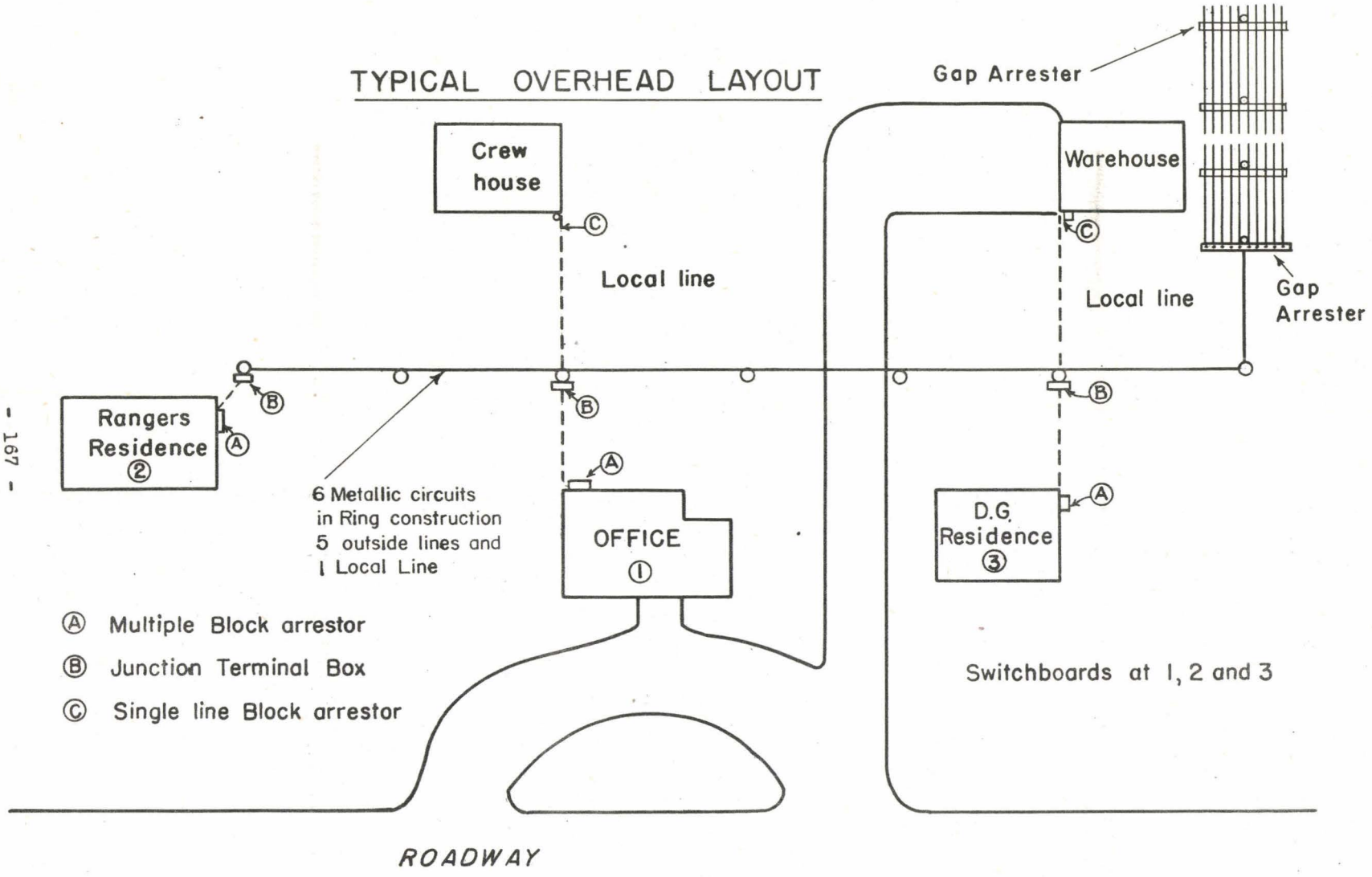
(a) Determine the number of buildings to be served by all of the lines, such as buildings having switchboards.

(b) Determine what other buildings need only one line, as when a single instrument is to be installed.

(c) Determine if more than one local circuit is needed to connect the local telephones, basing this determination upon the number of phones and the anticipated division of traffic.

(d) Layout pole and messenger line on a site plan in an arrangement that will give the best appearance, avoid turns, and occupy the most direct route consistent with other details. Junction poles where branch leads are to be attached should be placed so that the drop wires will lead to the right point on the building being served. Locate intermediate poles 1/2 the diameter of the pole to one side of the cable line. Junction poles should be located 1/2 the diameter of the pole to the side opposite the direction in which the branch line leads. A typical layout is shown in the illustration on page 167.

(e) Determine vertical clearances needed for the cable system. In general it is desirable to keep the cable system about 14' above ground except at road crossing where standard clearances are required.


TYPICAL OVERHEAD LAYOUT
Gap Arrester
Crew house
Warehouse
Local line
Local line
Gap Arrester
Rangers Residence ②
6 Metallic circuits in Ring construction 5 outside lines and 1 Local Line
OFFICE ①
D.G. Residence ③
Ⓐ Multiple Block arrestor
Ⓑ Junction Terminal Box
Ⓒ Single line Block arrestor
Switchboards at 1, 2 and 3
ROADWAY

(f) Determine if power and telephone construction can be placed upon the same pole, to avoid unnecessary poles.

140. Selecting the Route for the Overhead Cable System

When selecting the route for the overhead cable system consideration should be given to its effect upon the overall appearance of the station. In general the pole terminating the open wire plant should be located at the rear or to the side of the service area. This makes possible the selection of a route hidden from general view as the station is approached. If such careful selection of route is made, it will not be necessary to consider the use of the technically less desirable underground construction. Cable systems using messenger supports have sufficient strength to be placed among trees since limbs broken by winds will do no serious damage. Intermediate poles should be so located as to give short well-routed leads to buildings. Messenger cables should be run in as straight lines as practicable to avoid excessive guying.

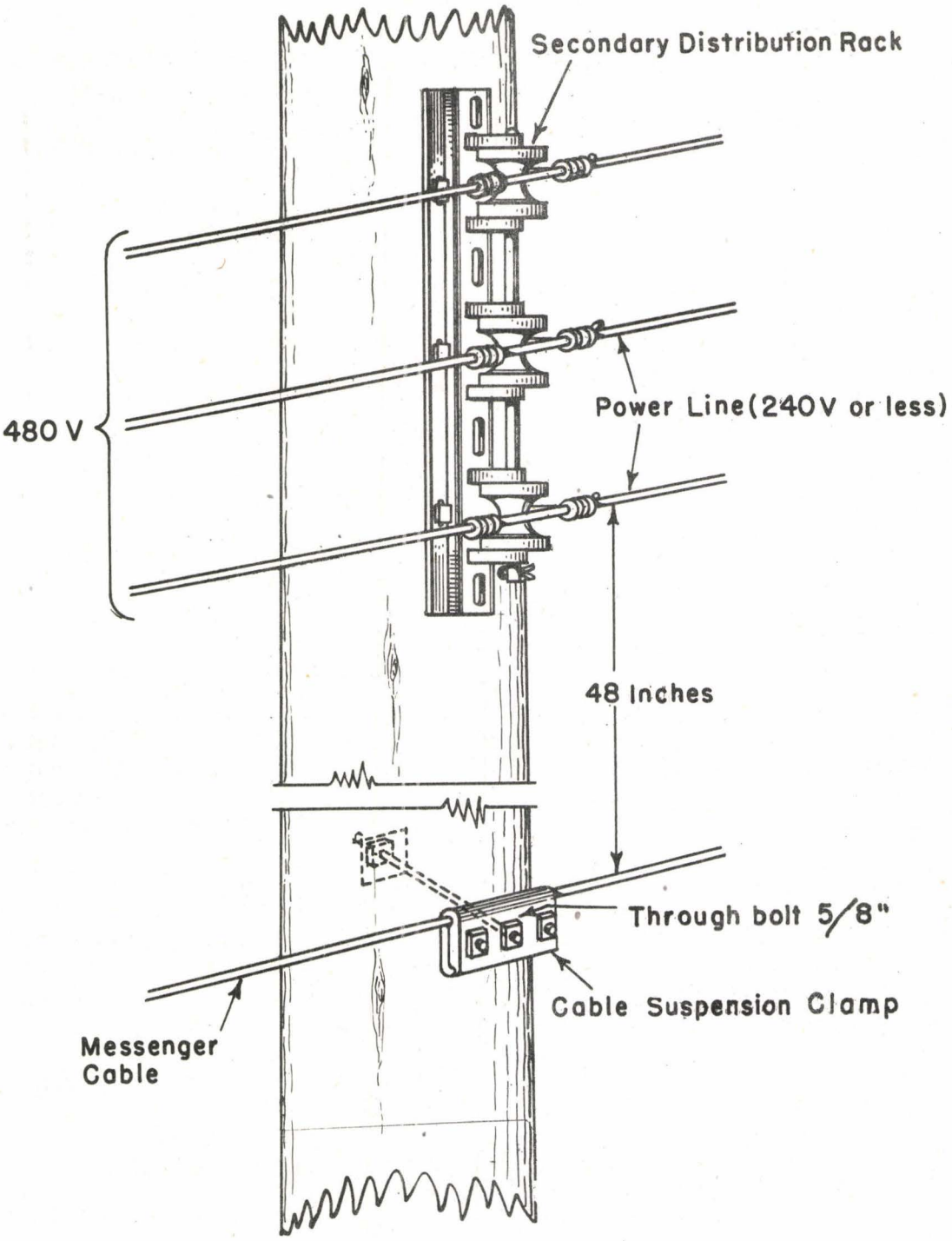
141. Overhead Construction

The use of drop wire in overhead construction will be the primary standard for all leads extending from the open wire plant to the various buildings requiring service. (See "Lookout Tower Entrance Construction" for exception). Messenger cable with cable rings will be used to support the drop wire when the number of lines exceeds three and when the length of the run is in excess of 75'. Local ice loading may require that unsupported span lengths be reduced or even eliminated regardless of the number of drop wires.

Messenger cables under tension should not be terminated on frame buildings or other structures of light construction in lieu of pole. In some instances buildings may be used to support the vertical weight of the cable at an intermediate point. Use a pole to terminate the messenger cable near the building and if ice loading is a problem a slack messenger may be required to give additional support to the drop wires. In most instances the messenger from pole to building will not be required regardless of the number of wires if the distance does not exceed 20 feet (See details of construction on page 169)

Parallel type drop wire will be standard for all drops except:

(a) When drop wires are exposed to exceptionally heavy power circuits and noise problems require the use of twisted pair having more transpositions than can be easily made with the parallel type.



JOINT POWER AND TELEPHONE CONSTRUCTION

(b) When the drops carry a metallic phantom circuit, in which case the two drops forming the phantom group should be twisted pair and two twisted together giving a transposition at least every three feet.

The successful use of drop wire will largely depend upon the close adherence to the standard types of associate hardware and fittings shown in this handbook.

Drop wire is not recommended for inside work. (See "Duct Wire")

Drop wire should not be installed in such a manner that snow sliding from roofs will cause damage to the wire.

142. Selecting and Listing of Material

Make pole list showing length and itemize material needed for each pole.

Compute length of guy strand needed for messenger and guys. Avoid splicing of the messenger.

Compute length of drop wire needed, adding approximately 8' for each drop to junction boxes or junction taps. Be sure to include sufficient drop wire to provide for vertical drops as at terminal poles and buildings. Determine if painted or stained poles are required (based on esthetic considerations).

143. Erecting the poles and messenger cables

Prior to setting the poles where grading is not necessary, install required hardware on the poles. Where grading is necessary, suspension clamps should be installed after the pole has been set - this allows for better grading.

Set poles, guys and anchors, using the same procedure employed for poles used in open wire construction.

Unroll the messenger strand on the predetermined side of the poles. Attach one end of the strand to one of the end poles. Place the strand in the suspension clamps and tighten just enough to prevent its slipping out while the strand is being pulled up. At the other end pole, attach pulling equipment and pull up to the required tension and dead end in guyeye bolt and tighten suspension clamps on all intermediate poles. While pulling up the messenger strand, men should be placed along the line to signal the operation back to the pulling crew.

144. Installing the Rings and Drop Wire on the Messenger

A cable car is preferred to a ladder for use in installing rings and drop wire on the messenger cable. This preference is based on convenience and safety. For safety, make sure the messenger cable will support the weight of a man riding a car or on a ladder leaned against the cable. A simple test for messenger strength consists of throwing a 1/2" or larger rope over the messenger at the center of the span being tested. Two men then place their weight upon the rope to test the cable.

In addition to the cable car and safety belt, provide a canvas bucket to carry rings and cable hangers. The bucket is attached to the cable car in a convenient position. A 20" stick with hooks for sliding along the cable should be used for proper spacing of rings.

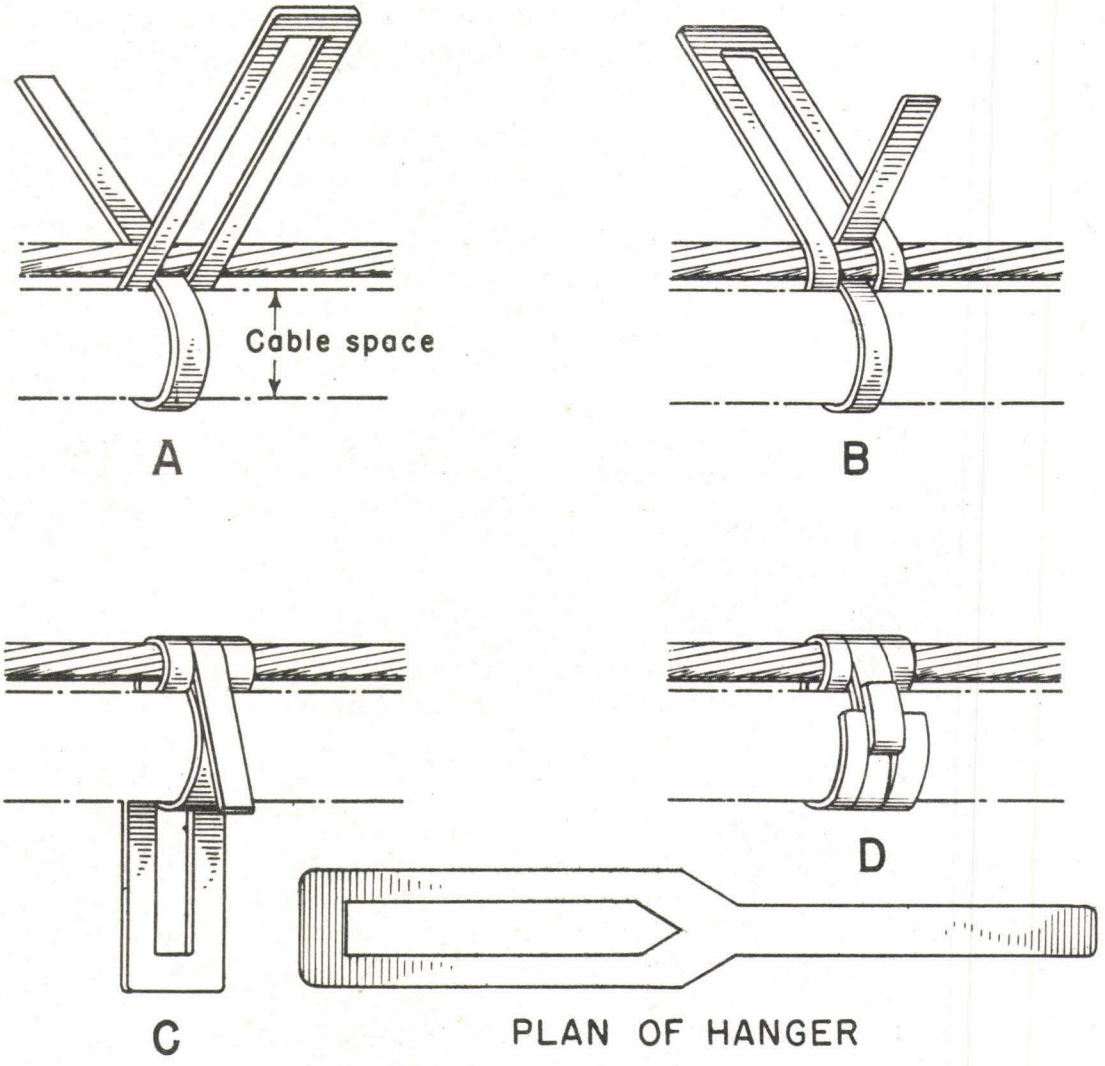
A pair of pliers is needed for installing the Davidson cable hangers.

The drop wires to be installed should be laid under and parallel to the messenger cable. To facilitate tracing the lines, terporary tags may be used on each end of each drop wire with an identification number or letter.

Place cable car on messenger strand. After the man gets into the car and attaches safety belt, he should pull up the bucket of rings, measuring stick, and the ends of drop wires with a hand line. Arrange supplies in a convenient position.

Allow sufficient length of drop wire to reach from the first cable ring to the terminal box or other attachment and to make desired connection. Install a Davidson cable hanger (see illustration page 172) at a point about 10" from the pole. Install the first ring about 20" from the pole, placing the drop wire inside the ring loop. Place the next ring on the messenger cable 20" from the first ring and in each case have the drop wire in the ring loop before clipping the ring on the cable. The hanger acts as a snubber for the drop wire, preventing the needed slack at the pole from being pulled out. Install the additional rings along the span with the drop wire in the ring loop. It is not necessary to keep any particular drop wire in a certain position relative to other wires. Where parallel drop wire is used, a twist at least every 19' is desirable. Twists should be put in wire as it is unrolled. When the next pole is reached, pull up surplus slack along the span and install a cable hanger in the manner and relative position described above. Rings should be spaced, when hanging drop wire, at the correct interval to make a neat and workmanlike job. This interval will vary from 12 to 20", depending on the number of wires.

CABLE HANGER



TYPE	LENGTH. IN.	MAX. CABLE SPACE
1	7 7/8	3/4"
2	11	1 1/8"
3	14	1 5/8"
4	16	2"

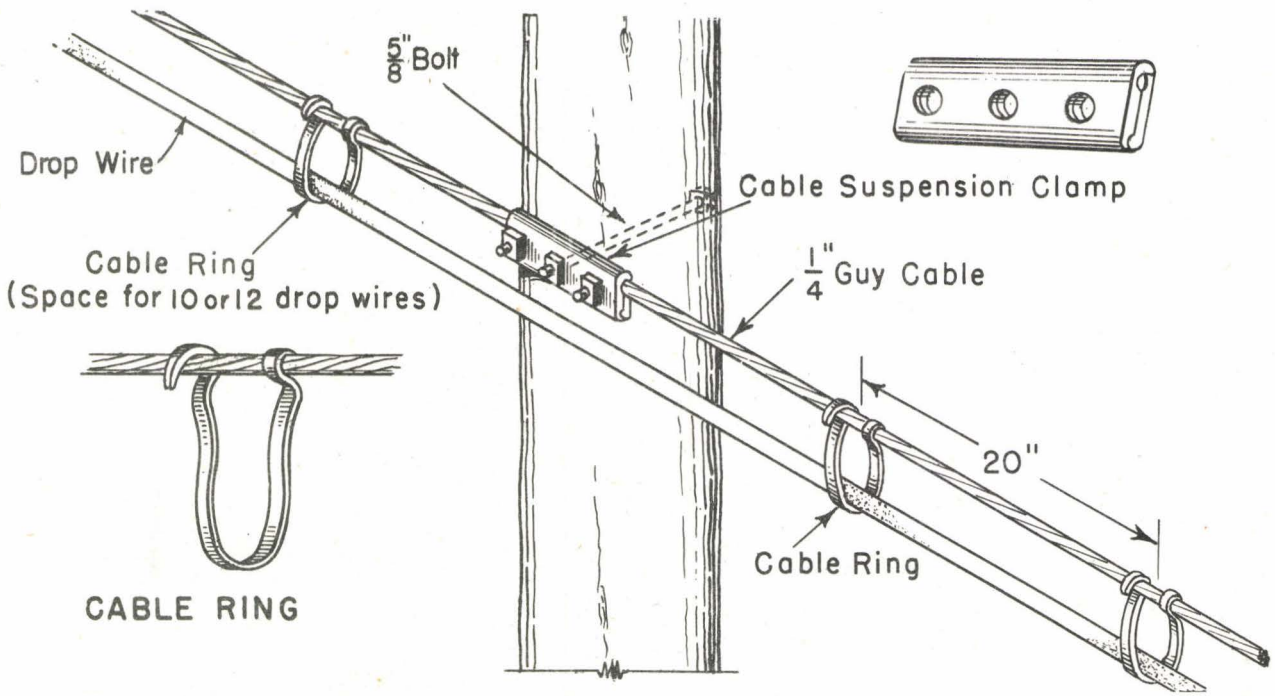
145. Connection of drop Wires at Terminals and Junctions

Where contact is made with the ring-construction overhead system, fasten the wire mechanically secure by use of drive rings or "C" blocks, as shown in the illustration on page 175 . Cut off excess drop wire, making sure to leave sufficient length for connection and future maintenance. It is a good practice to leave a loop of 6" to 8" below terminal boxes or protectors.

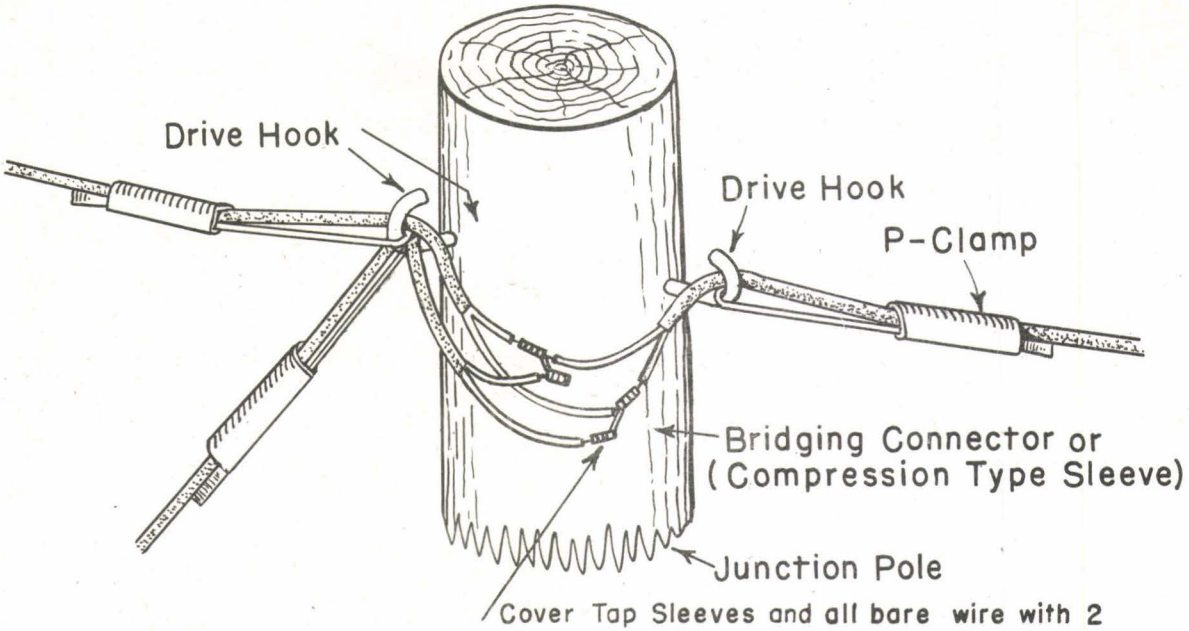
In many distribution systems there are several terminal and junction boxes to which lines are connected. Insofar as practical, the connections made at any one box or terminal should be identical to connections made at other terminal or junction. Such systematic arrangement facilitates maintenance and testing.

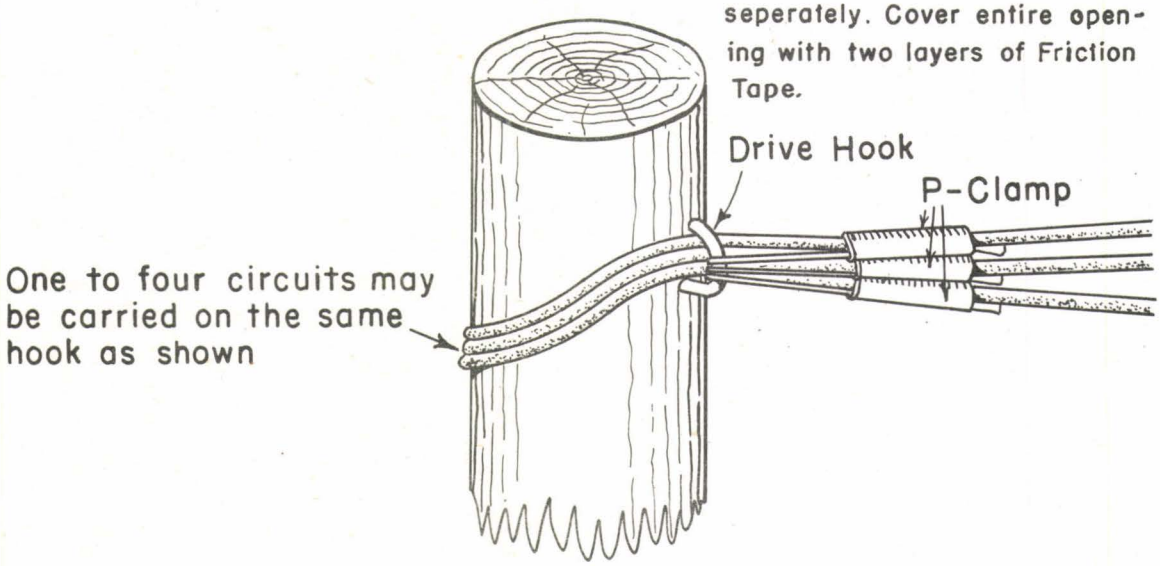
It is, therefore, necessary to identify the various drop wires and to identify each wire in the individual drop wire. (See page 176). Either a telephone or an ohmmeter may be used as the indicator of wire continuity. If the pair to be traced is purposely shorted at one position or junction a telephone will ring hard when connected to the correct pair. At this position the ohmmeter will show a low resistance continuity if the correct pair has been selected.

Prepare drop wire for connection to the junction terminals by removing insulation for a length of about 1" and make wire bright with sandpaper or scraper. Form a partial loop with a pair of long-nosed pliers and place under terminal nut, then close loop and tighten terminal nut.

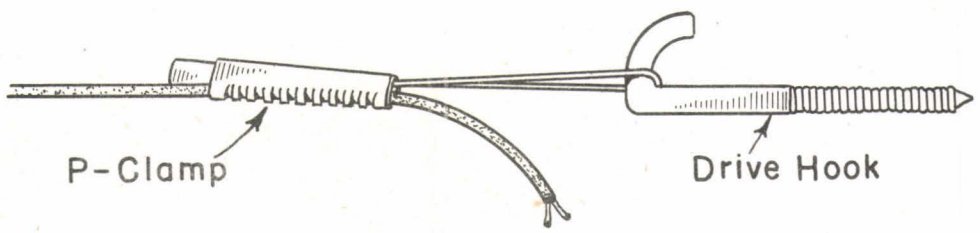


INTERMEDIATE POLE CABLE ATTACHMENT


Drive Hook
Drive Hook
P-Clamp
Bridging Connector or
(Compression Type Sleeve)
Junction Pole
Cover Tap Sleeves and all bare wire with 2 layers of Rubber Tape, each wire taped seperately. Cover entire opening with two layers of Friction Tape.

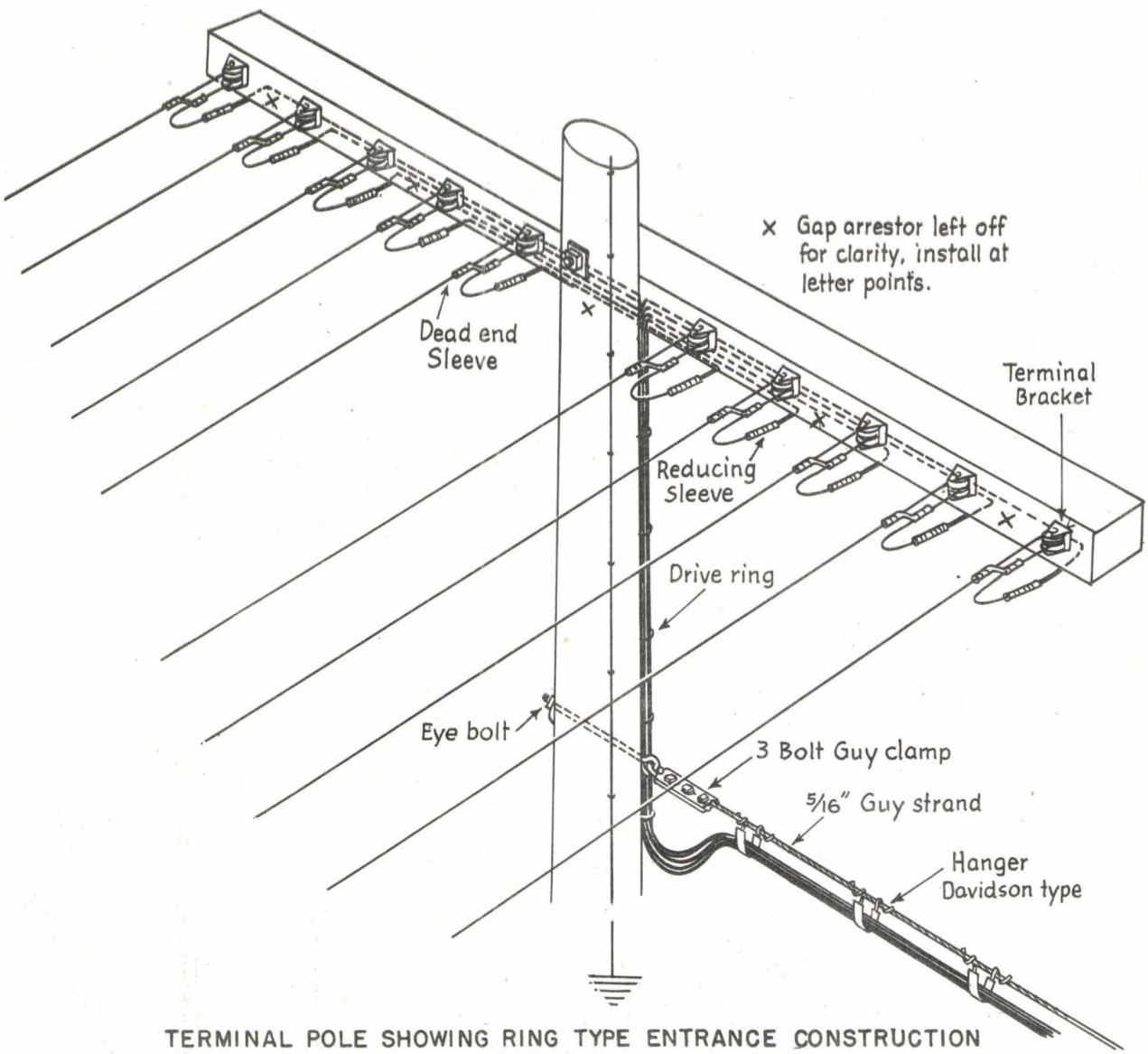


TELEPHONE DROP WIRE CLAMP

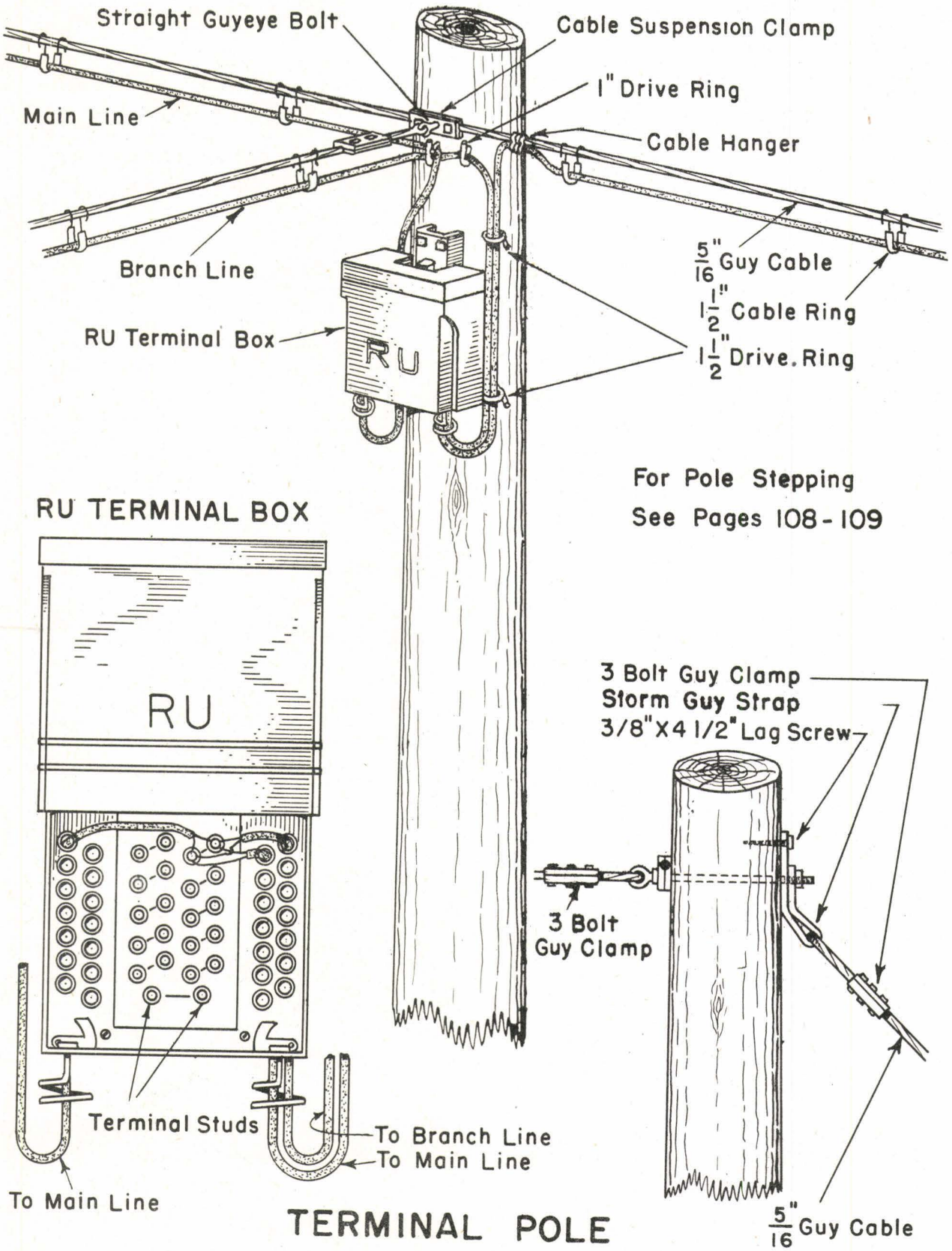


DROP WIRE CONSTRUCTION

Prepare drop wire for connection to the junction terminals by removing insulation for a length of about 1 inch and make wire bright with sandpaper or scraper. Form a partial loop with a pair of long nosed pliers and place under terminal nut, then close loop and tighten terminal nut.



TERMINAL POLE SHOWING RING TYPE ENTRANCE CONSTRUCTION



For Pole Stepping
See Pages 108 - 109

TERMINAL POLE

TERMINAL STRIPS AND CABINETS

146. General

Systematic wiring, additions and modifications and trouble shooting is greatly facilitated by adequate and well placed terminal junctions. This is especially true at the more complex stations such as ranger headquarters where there are several lines and several switchboards and extension telephones. By simple tabulations mounted within the terminal cabinet, lines can be readily identified, thus eliminating the time-consuming task of ringing out the lines. Such terminals eliminate the necessity of cutting the lines for test purposes and therefore preserves the original utility of the plant.

Such terminals provide the means of connecting together wires of differing gauges of materials without introducing mechanical difficulties.

147. Outside Terminal Junctions

The terminal junctions should be well protected from weather and other hazards. They should be mounted on appropriate poles and buildings as planning requires. Several examples of their use are shown on the sketch illustrated on page 167. It will be noted that four are shown in this arrangement and are placed at all of the main junctions of the station wiring system. For clarification, the following explanation is given: The terminal shown at the junction of the open wire lines and the ring construction cable system is for the purpose of isolating trouble to determine if it is on the open wire or with the local system. It would otherwise be necessary to connect the drop wires to the open wire with bridging connectors if systematic testing is to be provided. Experience indicates that the use of bridging connectors should be avoided wherever practical. Three other junction terminals are shown for the purpose of providing points from which extensions or drops may be connected to the main lines. They provide simple means of testing as well as a means of disconnecting drop leads from the main line during periods when all building connections may not be needed.

The following points relative to use of terminal blocks should be observed when planning the wiring of a station with ring construction:

(a) Enclosed terminals should always be used where there are three or more lines.

(b) Provide terminals at each main junction.

(c) Where future plans are not definitely established, provide at least 50% additional terminal space on the block.

148. Inside Terminal Junctions

Where several lines (3 or more) enter a building and it is necessary to route the wiring from the point of entry to another point within the building somewhat distant from the point of entry, it is not satisfactory in many instances to use the stiff and rather dirty outside drop wire for inside wiring. Duct wire is considered much better for the purpose, and in some instances multi-pair cable is better especially where 8 or 10 pair or more are involved. In many instances there are several extension telephones in the same building to serve the various desks occupied by administrative personnel. It is desirable that a central terminal strip be installed to which all telephones can be terminated. It is easy to understand that such terminals facilitate tracing of circuits, provide means of changing the wiring system as requirements change and avoid unsightly tangles of wires and taped splices. (See materials list for inside terminal junction boxes).

The following points relative to use of terminal strips should be observed when planning the interior wiring of a station.

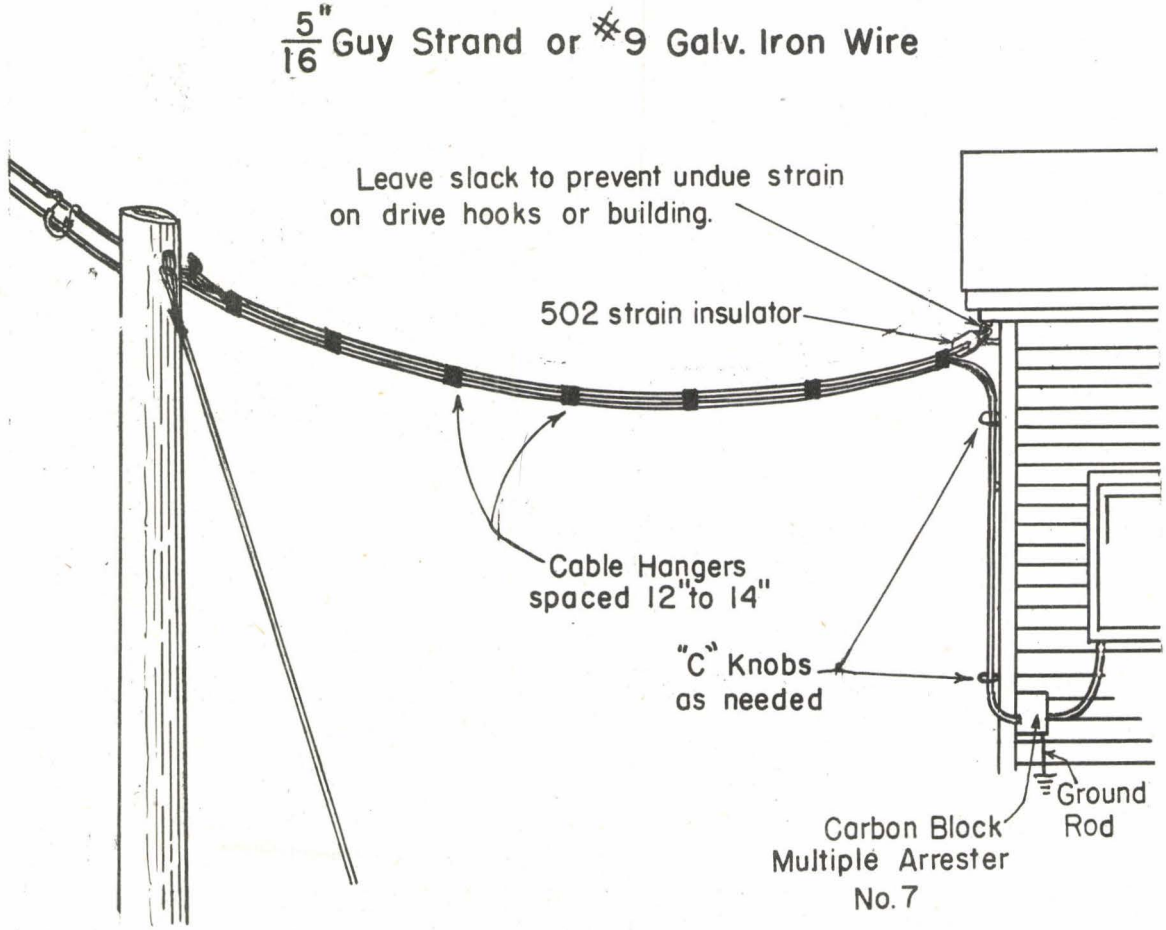
(a) Establish the amount of terminal space required and add 50% for future expansion.

(b) Locate the terminal strip in a position that will allow easy inspection and will give the shortest and best wiring route.

(c) Usually only one such terminal is needed in a building but in some instances two strips may be desirable.

(d) It is not desirable to combine telephone circuits with central switchboard battery or power ringer voltages on the same terminal. Use separate terminal strips for batteries and ringers and for lines. This is for safety reasons.

Unless it is practical to run the wiring direct to the instrument two point terminal strip should always be used where a conductor pair is connected to an instrument. Even in this instance it is sometimes desirable to provide the junctions to facilitate relocation of the instrument as office rearrangement is required. Such two point terminals are also frequently used where two telephones or other instruments are to be bridged across the same wire. This avoids haphazard splicing methods.

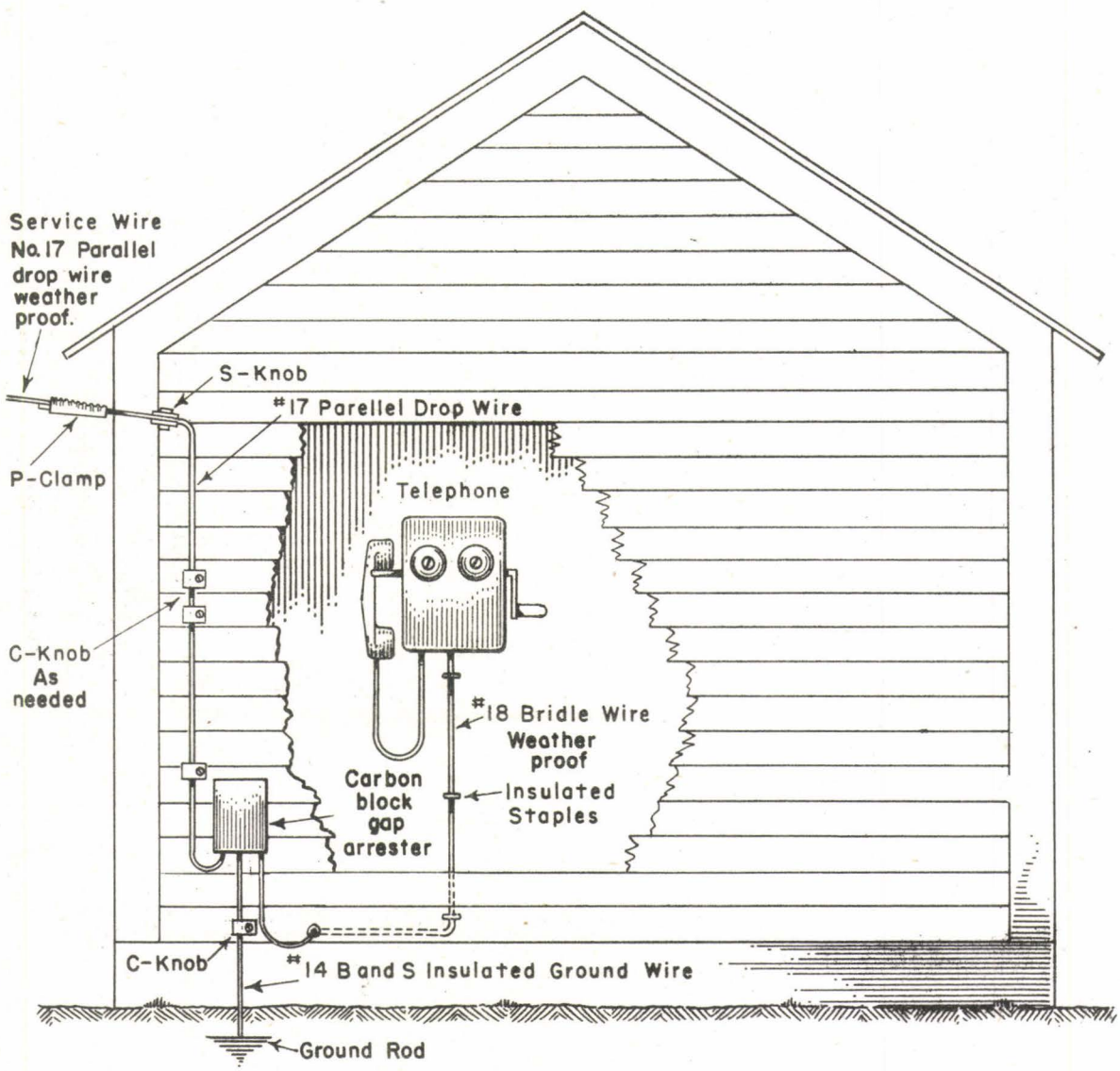

5/16" Guy Strand or #9 Galv. Iron Wire
Leave slack to prevent undue strain on drive hooks or building.
502 strain insulator
Cable Hangers spaced 12" to 14"
"C" Knobs as needed
Ground Rod
Carbon Block Multiple Arrester No. 7

ENTRANCE CONSTRUCTION, BUILDINGS
FOR MORE THAN 2 CIRCUITS

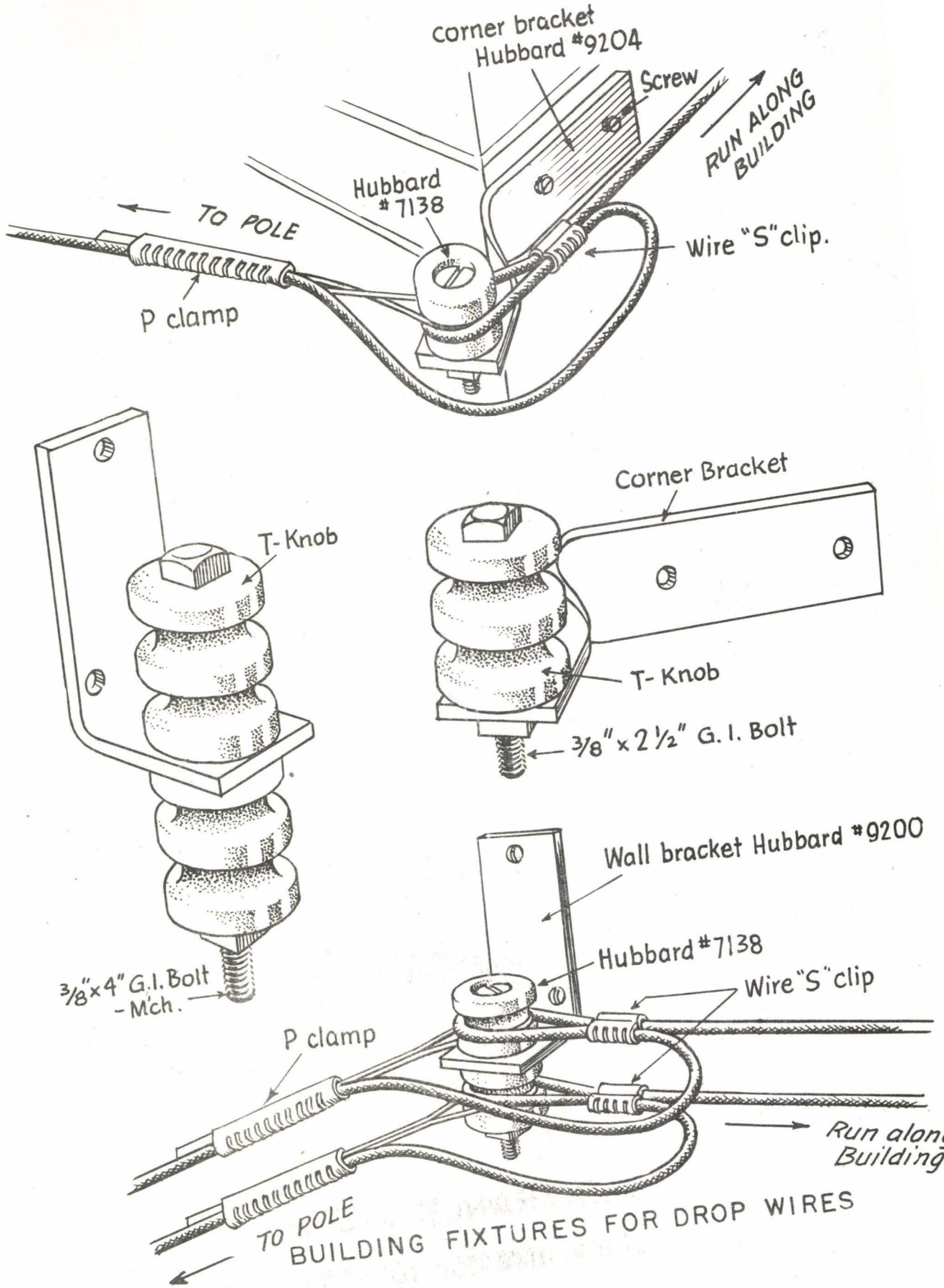
149. Entrance Construction - Buildings

Service wire for buildings, including observatories, should be overhead construction, using #17 parallel copper-covered drop wire from the terminal pole to the insulator mounted on the buildings. Use angle screw or wallbracket with S-knob insulator on building. (See pages 181-182). For more than three circuits use messenger and cable ring construction.

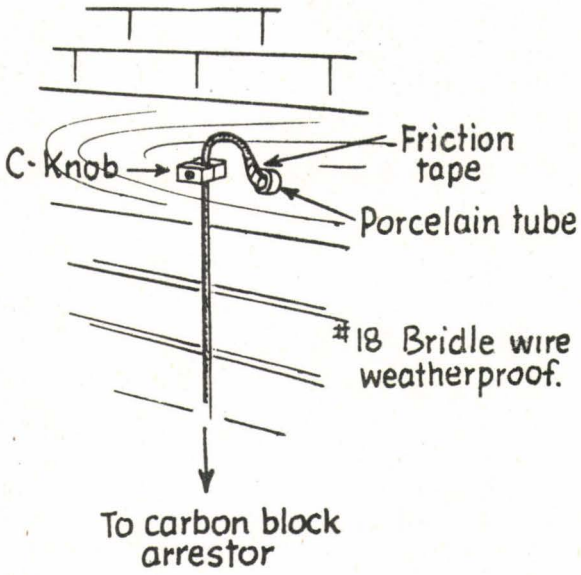
Where snow and ice loading is so severe to cause almost annual reconstruction of overhead entrance, underground entrance may be substituted. Follow instructions for underground construction.

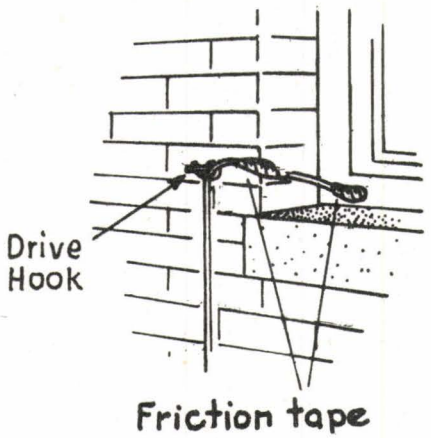


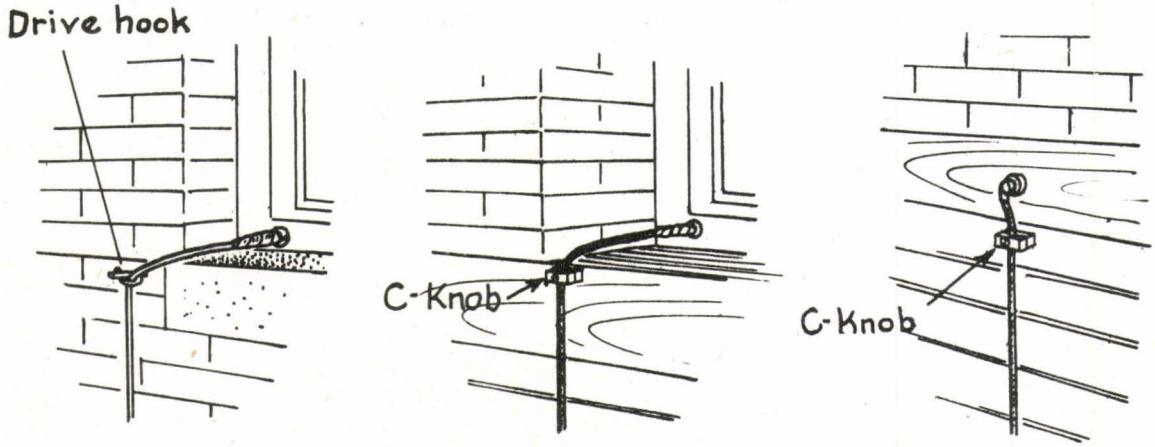
OVERHEAD ENTRANCE CONSTRUCTION



BUILDING FIXTURES FOR DROP WIRES

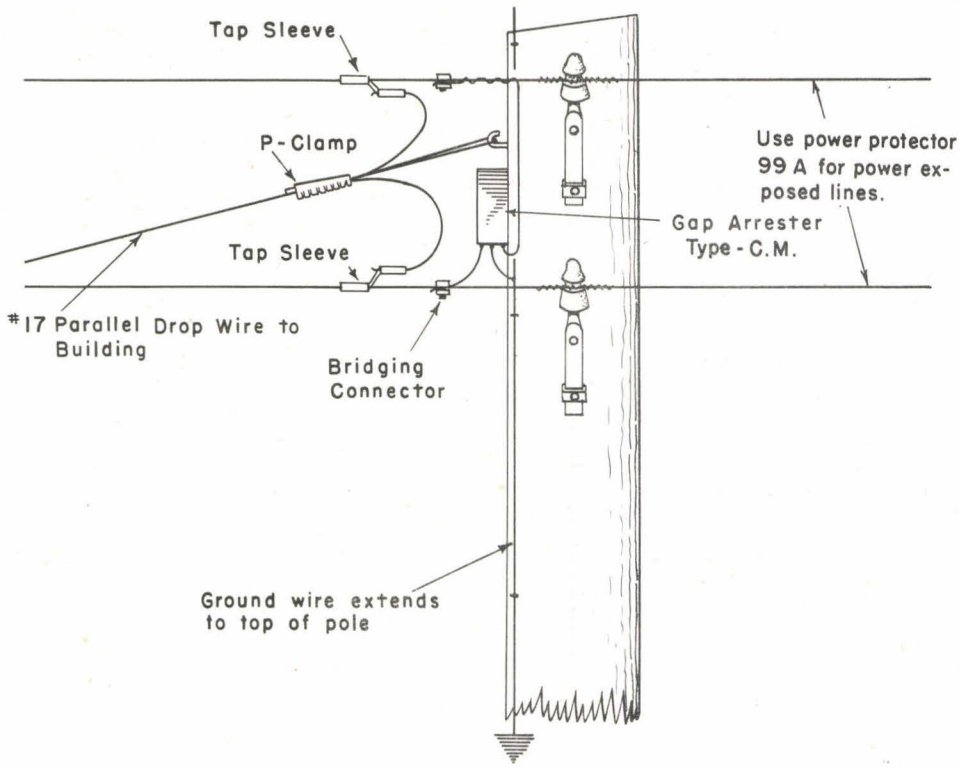




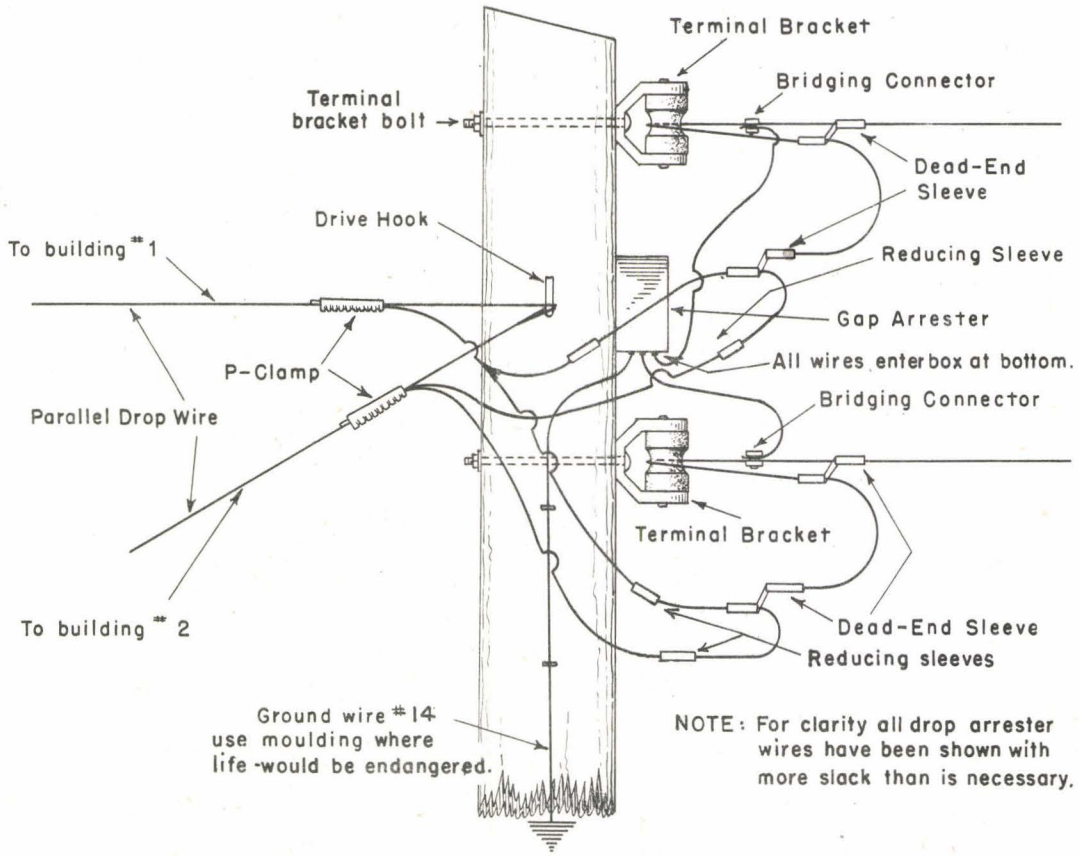


BUILDING ENTRANCE METHODS

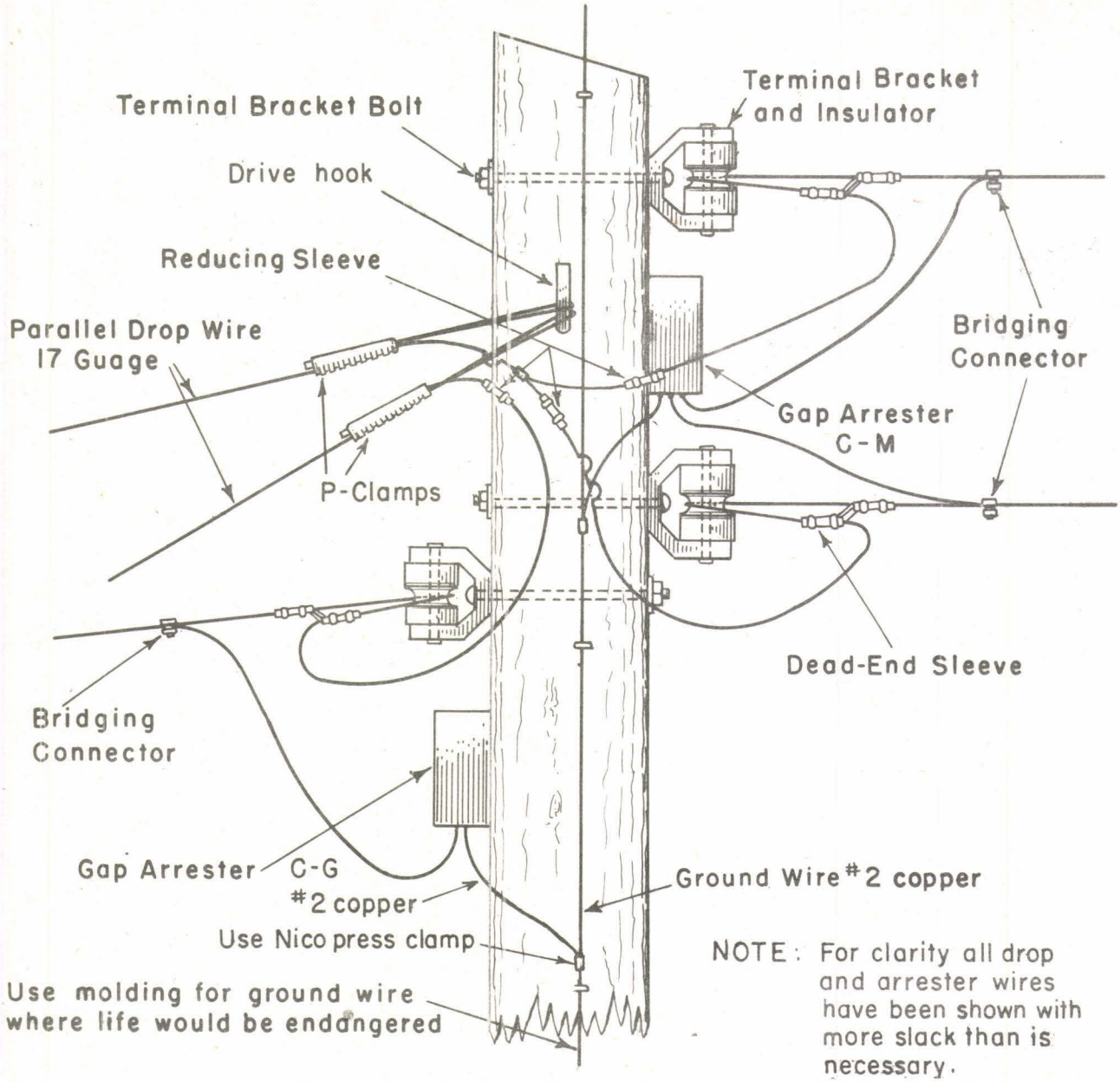
from carbon block arrestor to instrument


Tap Sleeve
P-Clamp
Use power protector 99 A for power exposed lines.
Gap Arrester Type-C.M.
Tap Sleeve
#17 Parallel Drop Wire to Building
Bridging Connector
Ground wire extends to top of pole

ENTRANCE DROP- FROM MAIN LINE



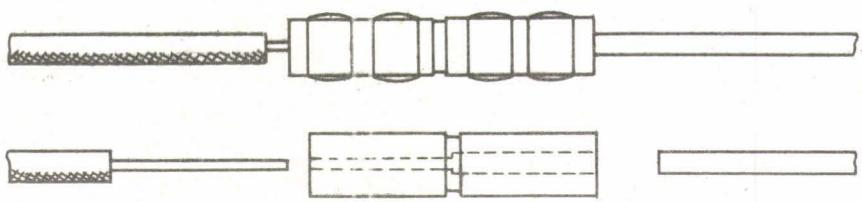
TERMINAL POLE-2 ENTRANCE DROPS FROM SINGLE LINE.


Terminal Bracket Bolt
Terminal Bracket and Insulator
Drive hook
Reducing Sleeve
Parallel Drop Wire 17 Guage
Bridging Connector
Gap Arrester C-M
P-Clamps
Dead-End Sleeve
Bridging Connector
Gap Arrester C-G #2 copper
Ground Wire #2 copper
Use Nico press clamp
Use molding for ground wire where life would be enddngered
NOTE: For clarity all drop and arrester wires have been shown with more slack than is necessary.

TERMINAL POLE FOR ONE METALLIC & ONE GROUND CIRCUIT RETURN

150. **Reducing Sleeves**

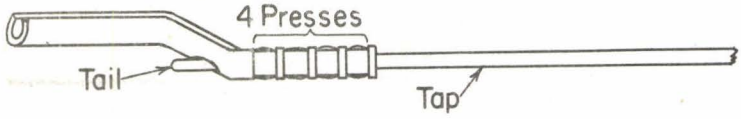
These sleeves are used at the end of the circuit for tapping service to the main line. Also for changing wire sizes in the circuit, as at the junctions of long and short spans.

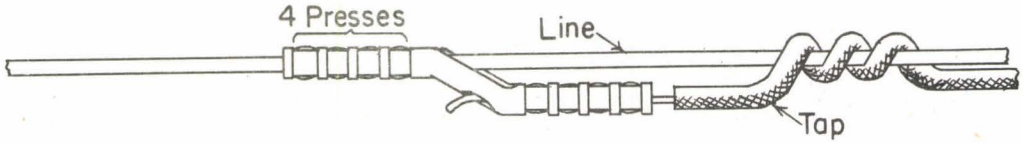


REDUCING SLEEVE

151. Tap Sleeves

Tap sleeves are used for making service-wire and spur-line taps. Before making a tap splice, be sure the wires are clean. For insulated wire, allow for 1/8 inch of bare wire between the ends of the sleeve and the insulation. It is advisable to tape a tap splice, even on bare wire to bare wire. It is not necessary to cut the main line when using a tap sleeve.





TAP SLEEVES

152. Splicing drop, Bridle, and Inside Wire.

These types of splices made with a 17-2 compression tool are primarily for the purpose of extending existing drop wire leads as well as for making splices of short lengths, 15' to 20', that would otherwise be wasted in many cases.

When splicing twisted pair or parallel wire, stagger the splices at least 3-1/2 inches. Each splice should be taped with one layer of rubber tape and two layers of friction tape. See below for correct steps.

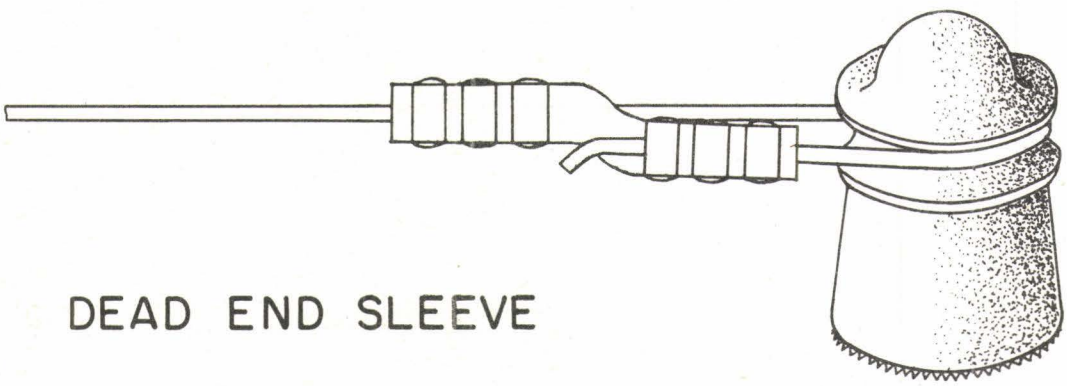
Shows splice before taping.

Rubber tape is recommended for each conductor splice.

Cover with two wraps of friction tape from braid to braid.

Shows splice of twisted pair drop or bridle wire before taping.

Rubber tape is recommended for each conductor splice. Use friction tape over rubber tape, each splice separately.



DEAD END SLEEVE

153. Entrance Construction - Heavy Loading

(a) Steel or Wood Towers

Entrance construction for heavy loading areas will be underground cable (see "Material") from the terminal pole to the tower leg. From this point to the inside of the tower cab, the cable should be attached to a tower leg on the inner-side of the tower by the use of, for steel towers, clips or wood wedge blocks; for wood towers, pipe straps of appropriate size. The cable should be terminated on the inside of the tower cab on a connecting block of proper size and type.

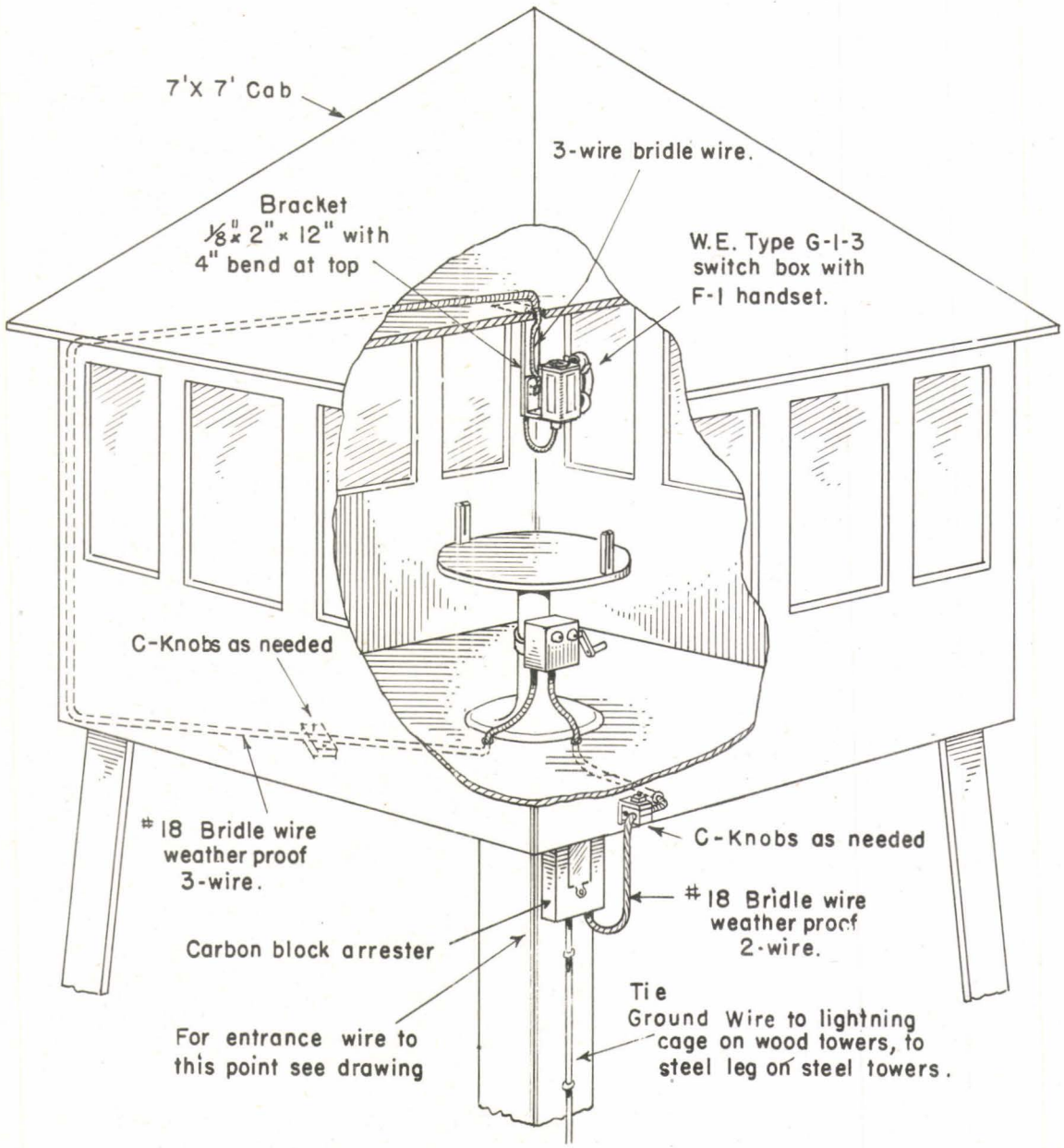
154. Entrance Construction - Light Loading

(a) Steel Towers

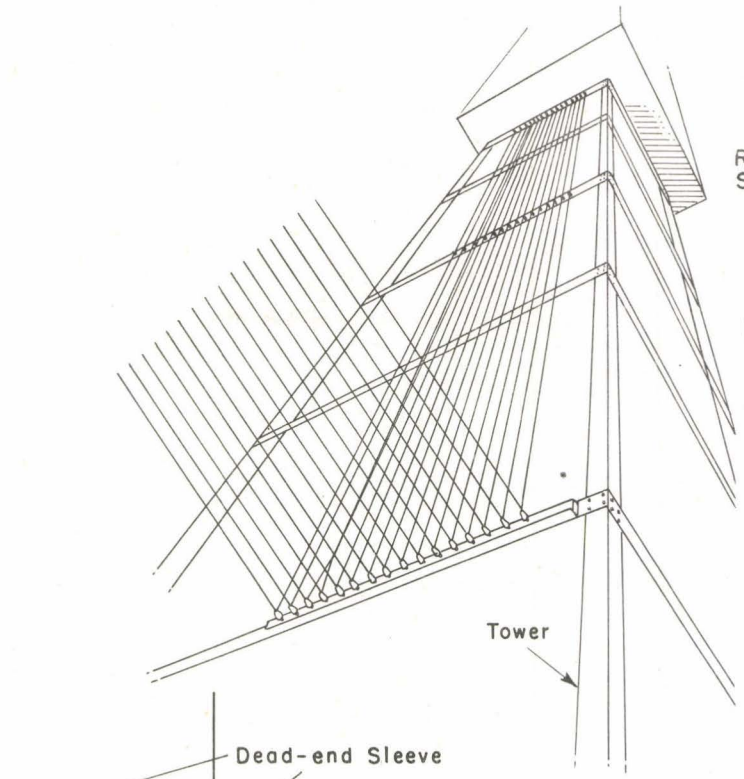
Open-wire entrance construction from the terminal pole to the cab of a steel tower can best be effected by the attachment of steel pins and line insulators to the tower. For a single circuit the pins should be placed on the outside angle of a tower leg. For two circuits two of the tower legs should be used. The attachment to the tower legs will require the drilling of 9/16" hole in the leg for each pin attached. For more than two circuits, crossarms attached to the horizontal members of the tower may be used. The space between attachments of either type should not exceed 15 feet and on towers where wind conditions are severe, the spacing should not exceed 10 feet. The first or bottom crossarm should be equipped with a double set of pins set at right angles to each other. All crossarms should be securely bolted either through the horizontal member or by the use of a "U" clamp and strap. Pins should be attached to the tower legs.

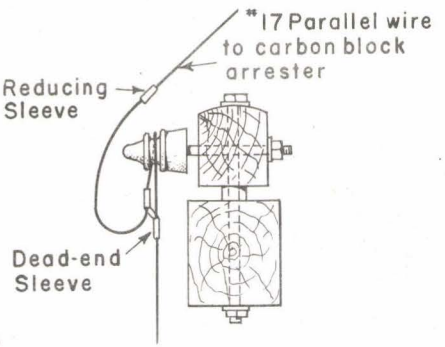
(b) Wood Towers

Open-wire entrance construction from the terminal pole to the tower cab should be similar to that for a steel tower, except that "lag screw" type of steel pin should be used for one or two circuits. Crossarms should be used on the horizontal members similar to those for steel towers.

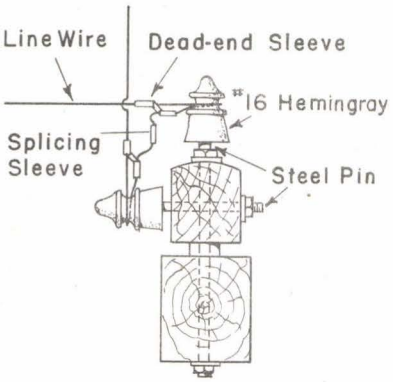


TELEPHONE INSTALLATION - TOWER CAB

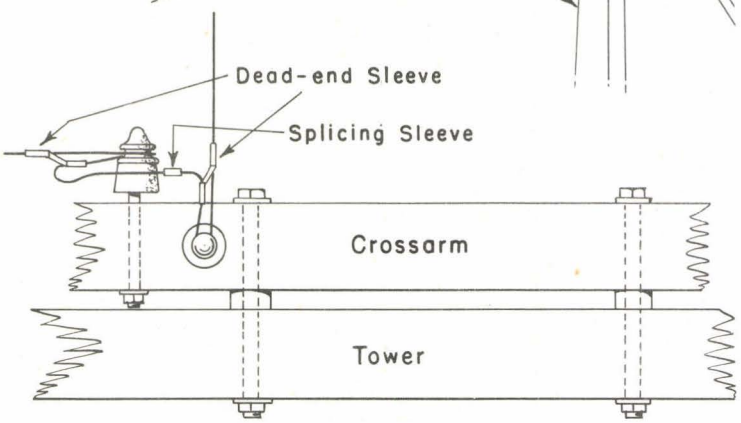




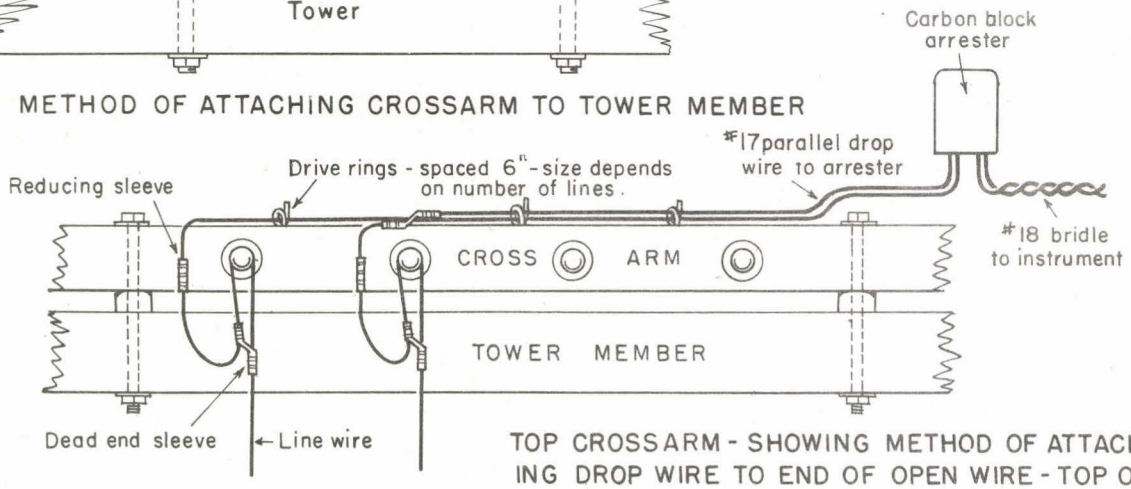
TOP CROSSARM



BOTTOM CROSSARM



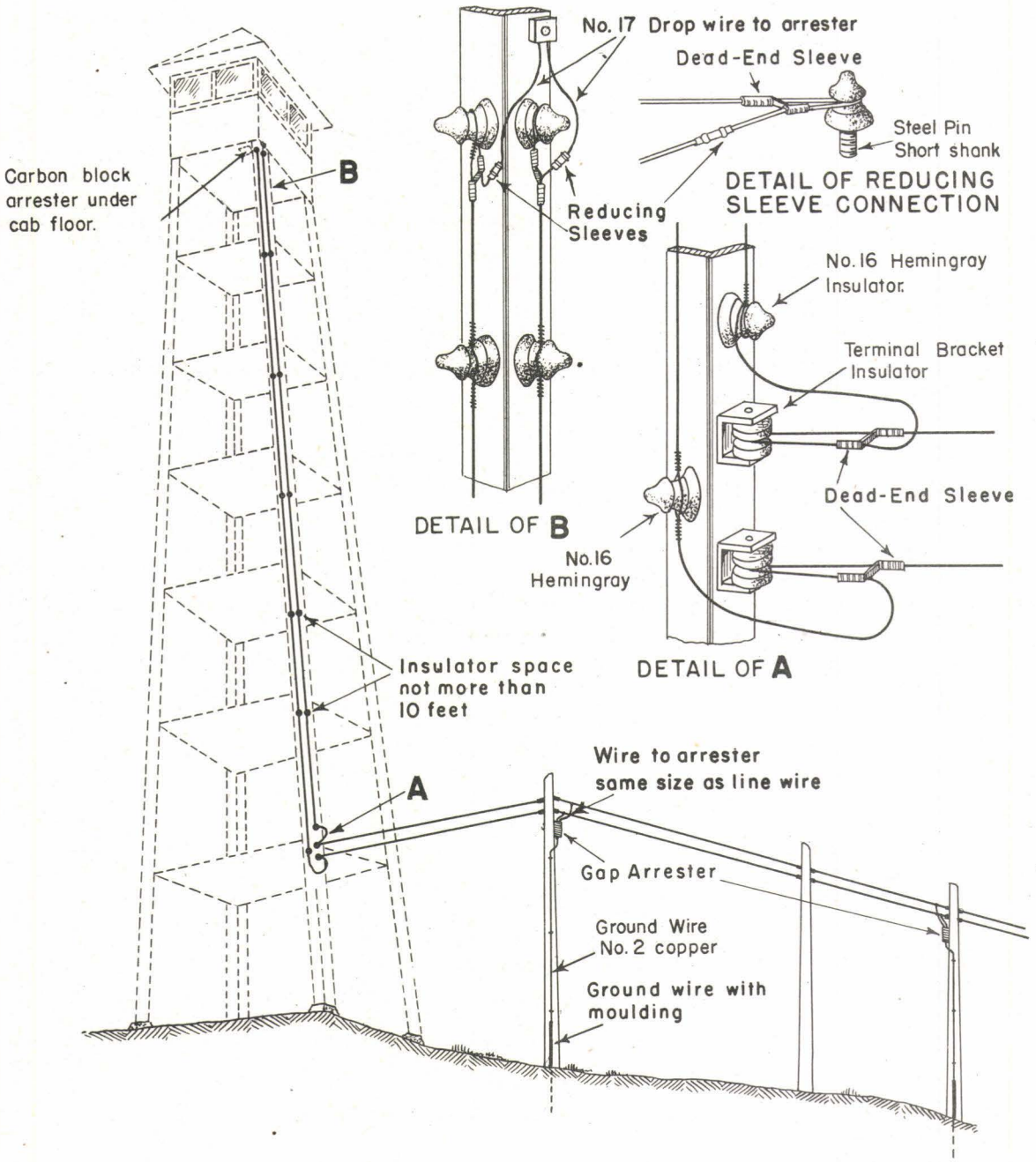
METHOD OF ATTACHING CROSSARM TO TOWER MEMBER


Carbon block arrester
#17 parallel drop wire to arrester
Drive rings - spaced 6" - size depends on number of lines.
Reducing sleeve
#18 bridle to instrument
CROSS ARM
TOWER MEMBER
Dead end sleeve
Line wire

TOP CROSSARM - SHOWING METHOD OF ATTACHING DROP WIRE TO END OF OPEN WIRE - TOP OF TOWER.

TWO OR MORE CIRCUITS ENTRANCE

STEEL OR WOOD TOWER



SINGLE CIRCUIT ENTRANCE — STEEL TOWER

154-A. Underground Construction

As a general practice, telephone conductors, whether cable or insulated wire, should be above ground. However under some conditions (rights-of-way, esthetic values, R.R., highway and power line crossings) the conductors may be buried. Experience has shown that more trouble occurs on buried conductors than on open wire construction and is also more costly. Therefor all underground construction must be justifiable and not because of a whim or fancy idea.

In addition to the above reasons, underground construction may be used where severe snow and ice loading occurs on lines that must function year long (over high country) or where experience has shown that the strongest open wire construction will be destroyed annually, such as at some lookout points. (Don't overlook radio for point to point service under these conditions. It may be more reliable and economical).

At stations where esthetic values demand underground construction "Trench lay" cable on the U distribution wire should be placed in conduits or tile ducts to facilitate repairs or replacement and to avoid damage or destruction to the asthetic values.

Lightning protection must be furnished each end of any underground construction. The use of ball gap arresters (CM for metallic, GC for ground return lines) on the open wires at the terminal pole and also on the second pole back from the terminal pole is required. These arresters should have low resistance grounds and good ground connections. The resistance should not exceed 10 ohms.

Where not more than two circuits are required #17 U distribution wire may be used. It should be buried below the frost line, never less than 12", in depth. This type of wire needs no additional mechanical protection. The wires are parallel copper #17 gauge and are sheathed in a covering of rubber which serves the double purpose of insulating the wires from each other and also from the soil and dampness. This wire is usually shipped on reels of 3000 feet and with lags weighs approximately 135 pounds.

The trench for the above wire should be as narrow as it is possible to dig. Any splices or taps should be designated by a stake driven above ground to facilitate relocating at any future date.

Where more than two circuits are required the cable should be made up internally of twisted pairs and where phantom circuits are involved and the length exceeds 1000 feet, quaded cable should be used. "Trenchlay" cable has proven satisfactory. Lead sheath cable should not be used. Underground conductors should be protected from power exposed circuits by the use of protector 99-A. These protectors should be used between the end of the power exposure and the cable not necessarily at the beginning of the cable unless the power exposure extends to the cable end.

Underground cable or wires should terminate at one end in a terminal box located on the terminal pole for the open wire and at the other end in a terminal box on a pole where entrance construction begins or in a terminal box conveniently placed on or in the building where the circuits end. Either cable or U wires should be protected with conductor pipe for a distance of approximately 12" underground up the pole to the terminal box. Avoid sharp corners in the conductor pipe.

Leave a small amount of slack in both cable or U wires at the terminal box. This slack can usually be placed out of the way in the terminal box.

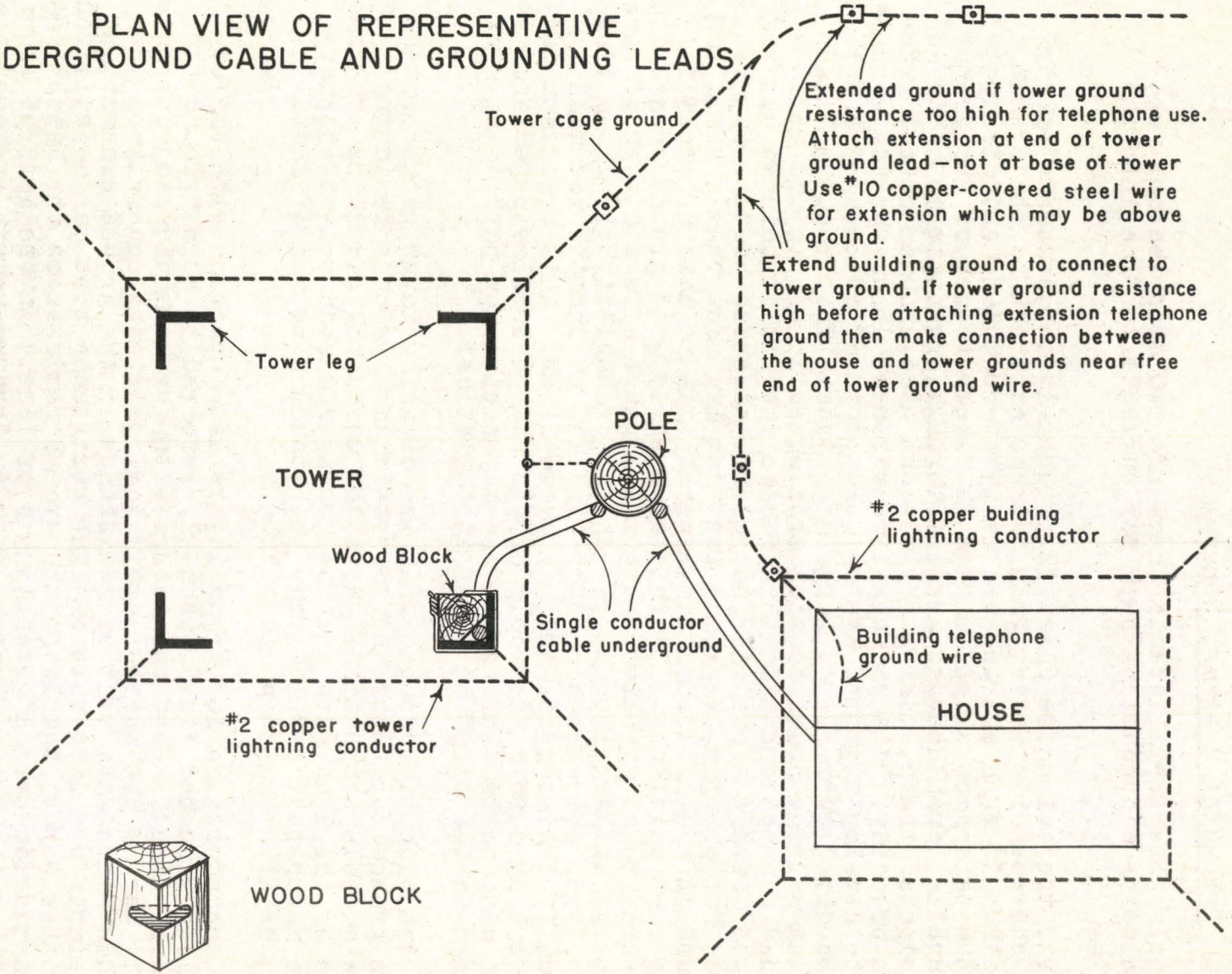
Where there is a good possibility of expanding any underground circuits sufficient slack should be left to take care of loading coils, and these points designated and marked by a permanent stake to facilitate future locating.

The wire (U distribution), should never be left exposed to light or unprotected from the weather for long periods, as the life of the rubber, though tough and will withstand the ordinary wear incident to placing, may be impaired by such exposure. For this reason the lags should not be removed from the reels until just before the wire is placed in the ground.

A single tooth rooter type plow can be used to advantage in preparing the trench for either cable or U distribution wire. Where a considerable footage, a mile or more, is to be placed under ground it may be found more economical to arrange for the rental of a special type plow designed especially for plowing the trench and placing the wire in the trench. The plow also refills the trench after the wire has been placed.

All pipe joints and ends should be reamed to remove burrs before pulling the wire through them.

PLAN VIEW OF REPRESENTATIVE UNDERGROUND CABLE AND GROUNDING LEADS


Tower cage ground
Extended ground if tower ground resistance too high for telephone use. Attach extension at end of tower ground lead—not at base of tower Use #10 copper-covered steel wire for extension which may be above ground.
Extend building ground to connect to tower ground. If tower ground resistance high before attaching extension telephone ground then make connection between the house and tower grounds near free end of tower ground wire.
Tower leg
POLE
TOWER
#2 copper buiding lightning conductor
Wood Block
Single conductor cable underground
Building telephone ground wire
HOUSE
#2 copper tower lightning conductor
WOOD BLOCK

155. Grounding Systems, General

In telephone installations there are two main reasons for developing a conducting path for currents to flow into the earth.

First, the telephone plant is frequently subjected to electrical charges originating from sources external to the system itself. If such charges are left to accumulate and dissipate in the telephone plant, damage is likely to occur. By proper grounding, such charges are led through arresters to earth and dissipated there. Arresters without good grounds cannot function properly. The principal requirement in protection grounds is to develop a ground system, all parts of which are capable of handling currents of large magnitude. This requires leads having a large cross section area of solid copper and well-bonded connections. In this connection, it is pointed out that ground testing alone will not assure adequate protection grounding. For example, a ground test set may show that a small rod placed in highly conductive mineral soil to have an exceptionally low resistance. If this apparently good ground connection is wired to an arrester using small gauge wire and then receives a charge of large magnitude, in all probability the connecting wire, rod, and even a part of the soil around the rod will actually disintegrate and may cause fires. This breakdown may occur long before the whole of the charge is dissipated and the remaining portion of the charge may seek a new path doing much damage to the plant or other installations.

The one exception to the practice of using large gauge protection ground conductor and low resistance grounds is in the case of pole protection. Here the conductor should be the same size as the line wire and the ground resistance left at whatever value that results from the standard method of installation as illustrated on page 112.

The second reason for grounding is in connection with the so-called "grounded line" (properly referred to as a "ground-return" line). Here the return path for communication currents is by way of the earth. Again low-resistance connections are needed since each unit of resistance in the ground connection is simply one less unit of line resistance that can be utilized. In other words, the lower the ground resistances the better the transmission over a given length of line. In the case of grounds used for the return current path in "ground-return systems" there are no heavy currents. In comparison to protective ground currents which flow during arrester action, even the ringing currents are exceedingly feeble. The above statement is not intended to mean that good substantial grounds and ground leads are not required for the telephone instrument. Physically such systems should be strong, stable, and arranged so that mechanical damage cannot easily occur.

Simple easy-to-operate test sets especially designed to measure the efficiency of ground systems are now available. The Service cannot afford to spend substantial sums on equipment and the construction of lines and have such lines and equipment prematurely destroyed or fail in operation for lack of adequate ground testing. Rule-of-thumb methods relating to grounds are not adequate.

Experience has shown that ground resistance does not remain constant and that tests should be made frequently enough to insure satisfactory service. Such tests should be made during the dry season.

Ground rods are commonly used when developing a ground system. However, other buried metallic objects such as water systems are also good grounds under certain conditions.

To establish definite standards of ground resistance for each class of service is not practicable. For instance, if the standard for all lookouts served by a grounded line were set at 50 ohms or less there would be considerable waste of funds and labor in some cases. An example would be dry rocky point connected by a short line to the dispatcher where the lookout will never need to talk beyond the dispatcher. Here a ground of perhaps 200 ohms would give satisfactory communication. If underground cable is used for entrance to the tower the lightning protection for the cable and instrument should not exceed 10 ohms. If, however, the lookout were on the far end of a long or heavily loaded line, it would be necessary to develop the best possible ground. It will frequently be necessary to construct extended ground leads to areas where satisfactory grounds can be established. Standard tree line construction should be used for such extended ground leads. Average ground resistance values and ground conductor sizes are shown in Section 165.

156. Practical Grounding Systems

There are many practical methods of developing satisfactory grounds. The following notes should be of assistance:

(a) The resistance of a ground usually depends upon:

(1) The type of soil in contact with the rod or object surface.

Clay type soils are usually excellent; sandy or gravelly soils, even when damp, are seldom good; volcanic ash type is almost invariably poor.

(2) Moisture in the soil

Where possible select areas that have natural or artificial irrigation or areas where evaporation of soil moisture is retarded during dry periods.

(3) The area in contact with the conducting soil

In some instances where soils are deep, this contact is best obtained by driving deep rods. Where soils are shallow, conductors laid horizontally, are more practicable where soil freezing will not become a factor see page 197, on freezing. In nearly all cases, the resistance of the earth connection is dependent upon the soil immediately around the rod or grounded object. It is conceivable that a small area selected for a ground could be exceptionally efficient and yet small areas could be insulated from the rest of the earth. Such conditions are quite easily determined where a line from the area to a distant ground of known resistance is available.

157. Metallic Objects Suitable for Grounding

Ground rods. Rods offer the most convenient type of ground conductor for deep mineral soil. These should be driven their full length into solid soil. If driven in freshly tamped soil near pole considerable time will be required before the contact with the soil would be as good as when driven into the undisturbed soil a foot or so from the pole.

Extension rods are available for deep grounds needed in some instances to reach a permanent water table, or better conducting soils.

158. Water Systems

Water systems or other buried metal pipes exposed to soil are usually excellent grounds. In making connections to these systems make sure that the pipe joints between the ground wire connection and the buried portion of system are making good contact. The resistance of water systems can sometimes be lowered appreciably by driving a ground rod near the pipe at some point where there is seepage as at a hydrant or drinking fountain. Such a rod should be bonded to the water pipe. Soldered connections to join ground leads to water systems are not satisfactory. Use a tinned copper strip clamp, type #1 Reliable or equal.

159. Caution

Ground connections should not be made to pipes carrying inflammables such as gasoline or illuminating gas. This also applies to underground gasoline storage tanks. Grounds should

not be made to ground wires or conductors used in grounding any part of an electric power system, except the lightning protection system which is usually the only ground connection for power systems.

160. Sewage Systems

Systems carrying away drainages from septic tanks have been used at numerous installations to develop excellent grounds. Since these systems are of non-metallic tile, it is necessary to install rods or buried wires, as the contacting surface. Where this soil is deep, one or more rods driven alongside the tile is preferable. In shallow soil No. 2 copper wire in a trench dug alongside the drainage tile is better than the driven rod. Such wires laid along the tile should be in the moist soil below the level of the tile. Such installations are best made at the time the tile is laid; however, careful workmanship will give a good job on existing systems without damage to the tile.

Outdoor toilets make a good ground field where a rod or rods can be driven deeper than the pit. These rods may be placed outside of, but close to, the building.

161. Culverts

Galvanized iron culvert pipes, when in mineral soil, have been used as grounds with good results. However, the use of a copper-covered steel ground rod adjacent to the culvert would be better. The success of such grounds depends mostly on whether the soil dries out during dry seasons and upon the physical condition of the culvert.

162. Other Large Area Metallic Objects

Almost all metallic objects exposed to soil or even rock should be measured for ground resistance and used when found to be satisfactory. Such items as bridge foundations, cable anchorages, sprinkling systems, etc., are often serviceable as grounds. Connecting leads should be securely clamped or bolted to such objects.

163. Freezing of Grounds

As the temperature of grounds is reduced below 32°F the resistance rapidly rises and in some instances may reduce the effectiveness of a ground to the point where it will no longer give service.

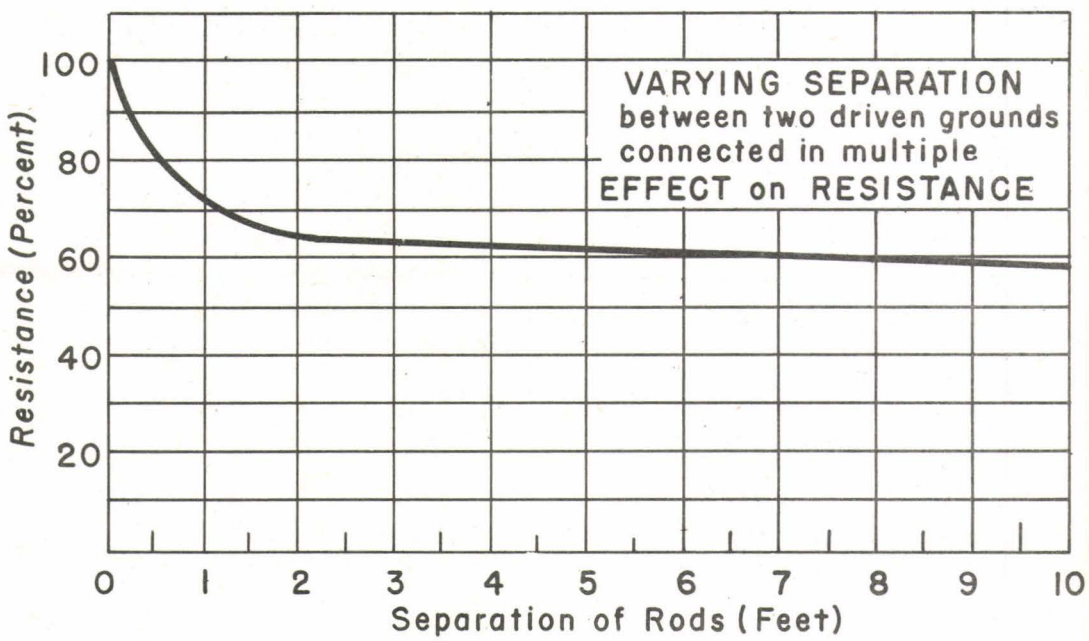
Rods or other objects below the frost line would not be affected. In some climates especial care will be necessary on those grounds needed for winter service.

164. Multiple Rods

Where a single rod is unsatisfactory due to high resistance and for reasons of shallow soil, a longer rod is not practicable; the addition of one or more rods driven in the same area and connected together will often reduce the ground resistance to a satisfactory level.

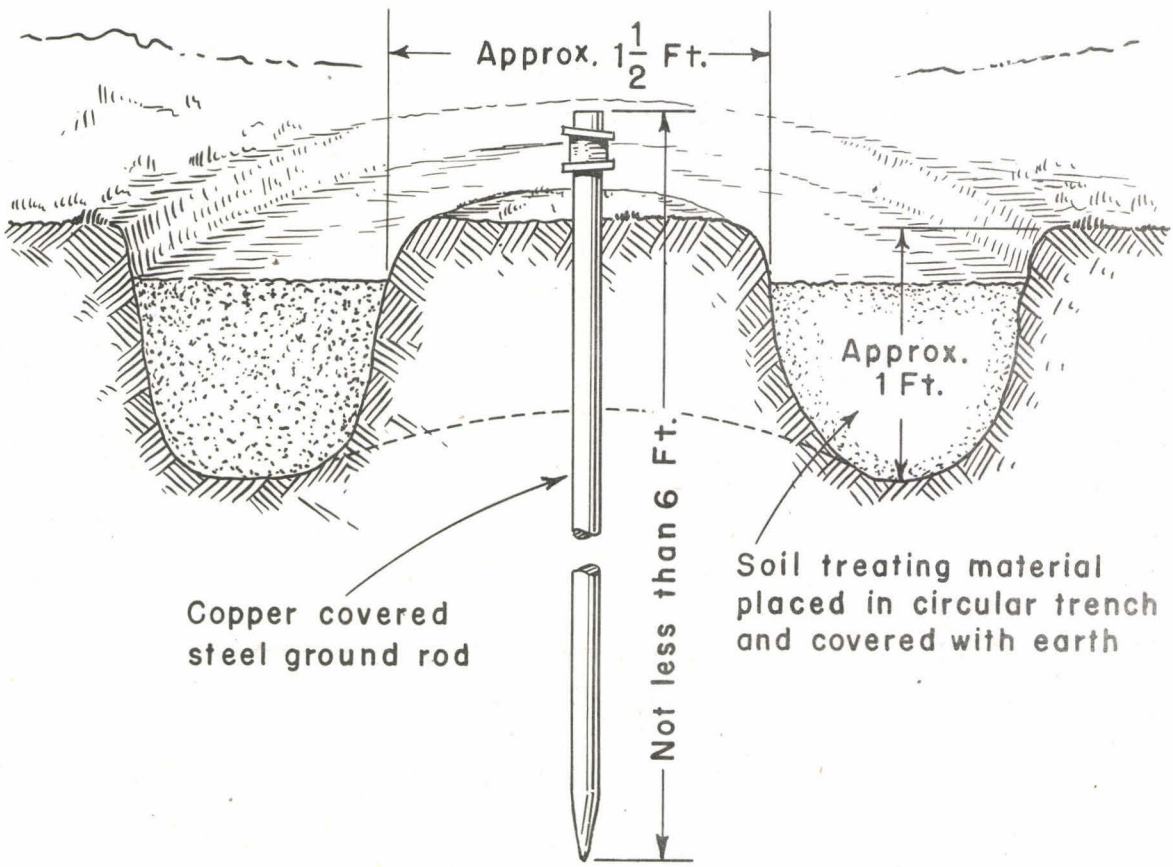
As will be noted from chart below the use of two ground rods connected in multiple and with a separation of six feet will lower the resistance from approximately 72% for one rod to an even 60% for the two. Often a third rod, connected in multiple, with the same separation (6 feet) will reduce the resistance another 12% or to 48%. Wires connecting multiple rods should be underneath the surface out of reach of pawing or digging animals. The connecting wire should be copper or copper-covered steel not less than #10 gauge. The wire connections to the ground rod should be made by the use of a ground rod clamp.

Experience has shown that with few exceptions the 5 foot copper-covered ground rod is sufficient to obtain a good ground. The slight decrease obtained in the resistance by spreading the multiple grounds more than 6 feet does not appear to be justified.



165. Chemical Treatment

In soils where the mineral content is low, real betterment can be accomplished by applying salt in the proper manner. This is applied as shown in the cut below. Use about 50 lbs. of rock salt to treat each rod. As salt is readily soluble in water, the salt content of a treated soil will change as the salt is carried away by leaching. On an average, the resistance of a ground can be reduced by 75% to 80% and will remain effective for about 12 to 18 months at which time the salt should be replenished. The salt should not come directly in contact with the rod as excessive corrosion may occur. Multiple rods, without salt, may be necessary to secure a satisfactory ground in areas where deer and other game are plentiful if protection to the ground connections from animals cannot be assured.


Approx. 1 1/2 Ft.
Approx. 1 Ft.
Not less than 6 Ft.
Copper covered steel ground rod
Soil treating material placed in circular trench and covered with earth

CHEMICAL TREATMENT OF GROUND

The table below should be used as a guide in grounding. The resistance values given are to be considered approximate maximum values and should be reduced to the lowest practicable value commensurate with reasonable use of material and labor.

Ground Resistance Values

Purpose of the Ground	Maximum Resistance in Ohms	Ground Lead
Pole Protection Grounds	Measurement not necessary	Line wire
*Gap Arresters Protecting Entrance Cables, Underground Construction	10	No. 2 copper
Gap Arresters at Lookouts - Guard Station, (Instrument Protection)	Tie to Lookout Prot. 25-50	
*Gap Arrester at Repeat coils	20-50	No. 10 copper weatherproof
*Carbon Block or Vac. Arresters. Power Protector #99A	100	No. 10 copper weatherproof
*Telephone grounds for local service	10-200	No.10 copper
*Ground common to 2 or more circuits where crosstalk must be avoided	20	No.10 copper weatherproof
*Telephone ground for average service	50	No. 10 copper weatherproof

*Measurement of ground resistance required.

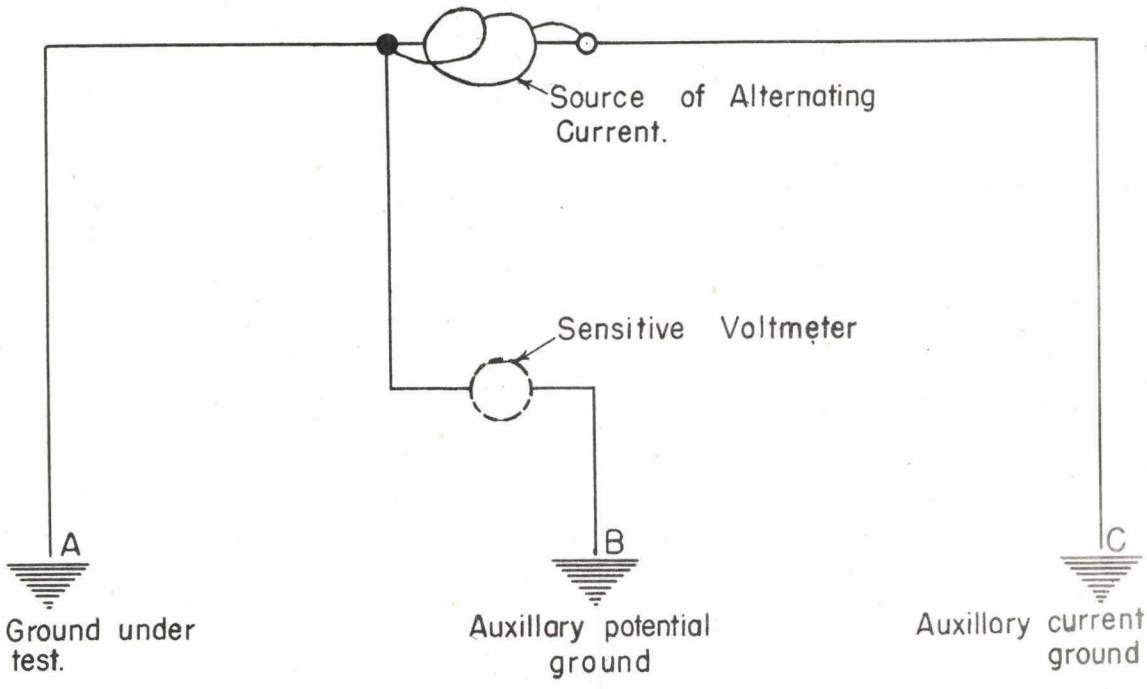
166. Testing Grounds

There are several types of direct reading ground testing instruments available which give ground resistance in ohms. Essentially the principle of operation is the same for most types. Two auxiliary rods on other ground connections are

used spaced about 50' to 100' away from the ground being measured and leads connect all three grounds to the instrument. See sketch below.

Briefly, operation is as follows: The test set causes current to flow through the ground under test (A) and auxiliary ground (C). If there is resistance to the flow of this current at (A), then a voltage will exist between it and other points on the earth, as at (B). The sensitive voltmeter measures this voltage and indicates it in terms of ohms of resistance. The resistance of the auxiliary ground has essentially no effect upon accuracy of the measurements.

Ohmmeters are not recommended for measuring ground resistance since the value of the auxiliary ground is not known and to determine this value involves too lengthy a procedure to be practicable. Earth currents frequently upset these measurements.



GROUND TESTING METHOD
(Direct Reading Instruments)

LINE AND PLANT PROTECTION SYSTEM

166-A. General

Telephone systems are frequently exposed to electrical charges originating from nearby lightning discharges. In some instances such charges result from faults on, or actual contact with, power transmission lines.

It must be recognized that heavy direct strikes of lightning will almost invariably cause severe damage to some part of the plant regardless of how well it is protected. These cases are actually rare and any attempt to increase the standard of protection to fully take care of the problem would increase the cost beyond reasonable limits.

Proper installation and maintenance of protection will drain the unwanted charge to ground through arresters, whenever it reaches a hazardous value. Efficient arrester action cannot be expected unless good low-resistance grounds are provided.

167. Pole Protection Grounds

The standard conductor ground for pole protection will consist of two pieces of wire (same size and kind used for circuit wires). One piece of the wire should be attached to pole to extend about 4" in a perpendicular position above the top of the pole to a point about 8 1/2 feet from the ground where it will be formed to make a U. The other piece of wire should extend from about the bottom of the pole, up to approximately 8 feet from the ground where it will also be formed to make a U. The gap at these two U ends should be 4 inches. The wire should be attached strictly in accordance with drawing shown on page 112.

The introduction of the gap provides the necessary insulation from the ground for lineman working on the pole.

Ground conductors for pole protection should be installed on every pole in heavy lightning zones. In light and medium lightning zones the ground conductor should be installed on every fifth to tenth pole. The shattering of poles by lightning is an indication that more frequent pole protection should be installed. When in doubt as to the lightning zone be safe by increasing the number of poles having protection.

168. Line and Instrument Protection

The ball-gap type lightning arrester with a 1/16" gap will be standard for the primary protection system. This type arrester will be supplemented with a carbon-block arrester located within a few feet of the instrument. There follows a description of arrester types and where they should be used.

169. Ball-Gap Arresters - (C.M. for Metallic Circuits, C.G. for ground return circuits)

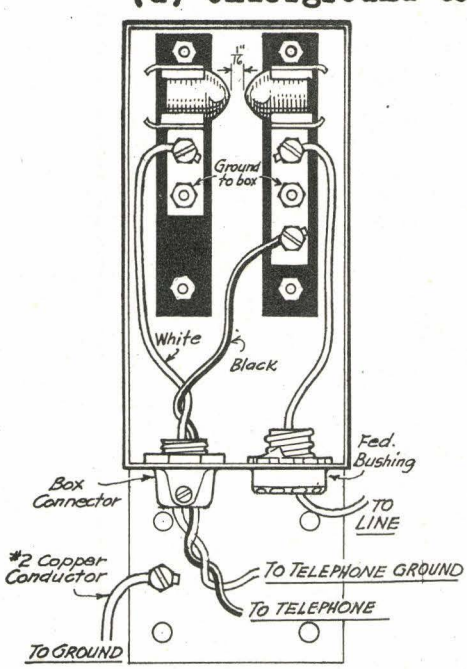
Install ball-gap type arresters at the termination of open wire lines where such lines join with:

(a) Cable systems (one arrester for each open wire circuit)

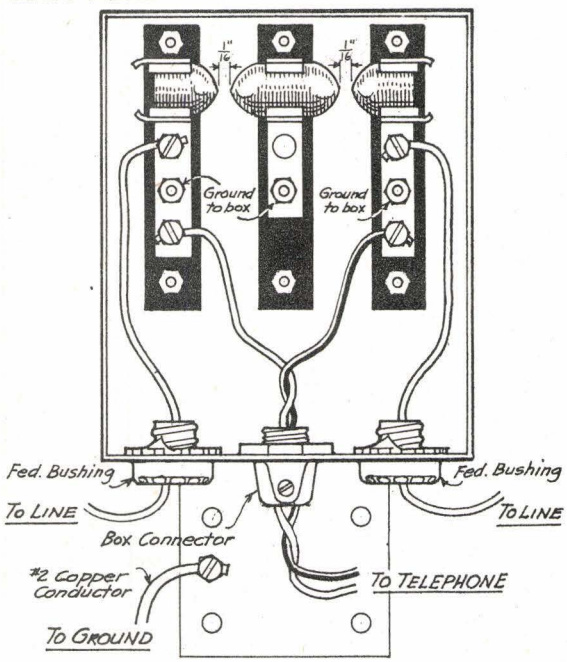
(b) Repeat coils (one arrester for each circuit)

(c) Telephone installations

(d) Underground construction

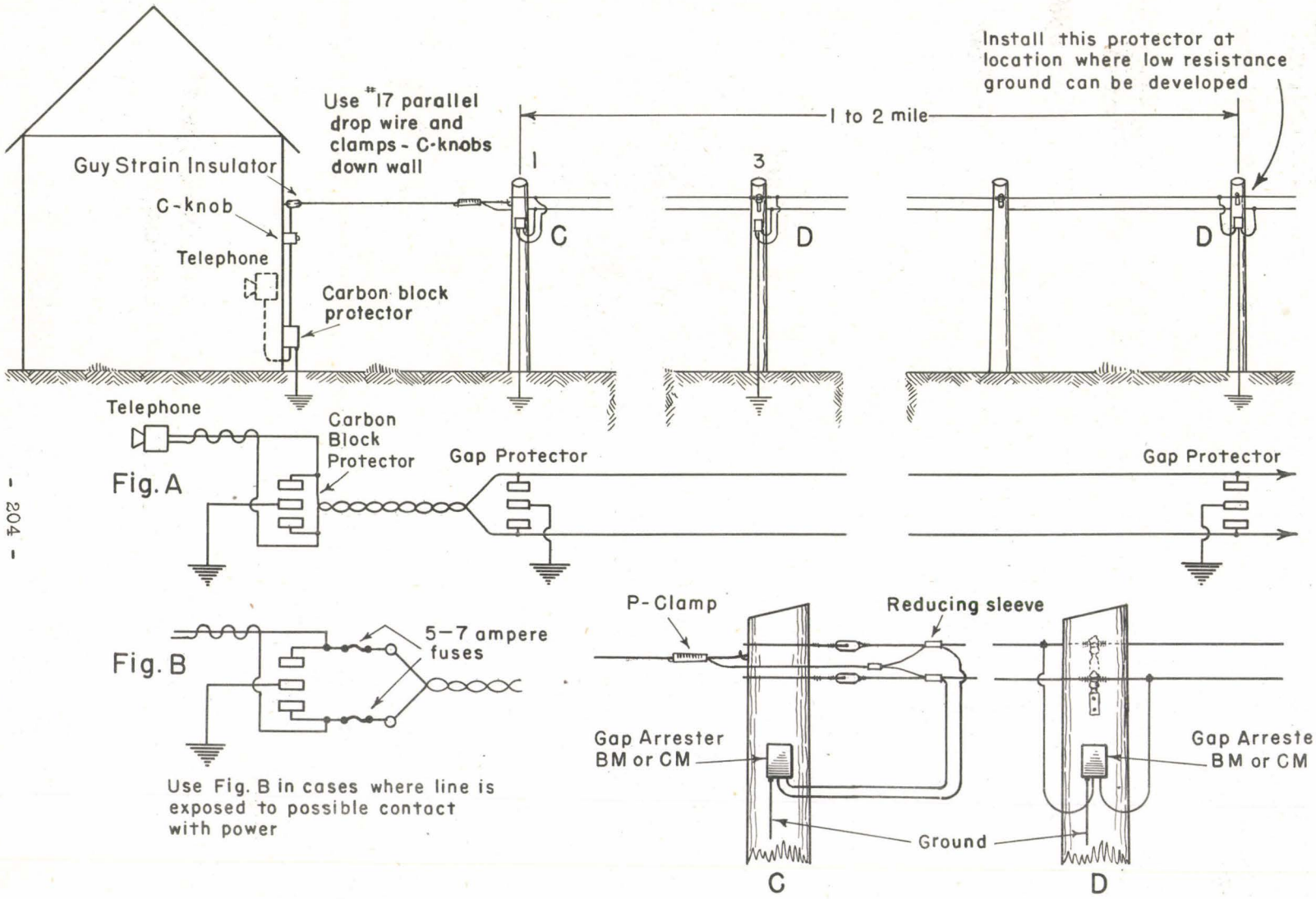


COOK-KELLOGG C-G
(GROUNDED CIRCUIT)



COOK-KELLOGG C-M
(METALLIC CIRCUIT)

TYPE C LIGHTNING ARRESTERS



PROTECTION PLAN FOR METALLIC LINE

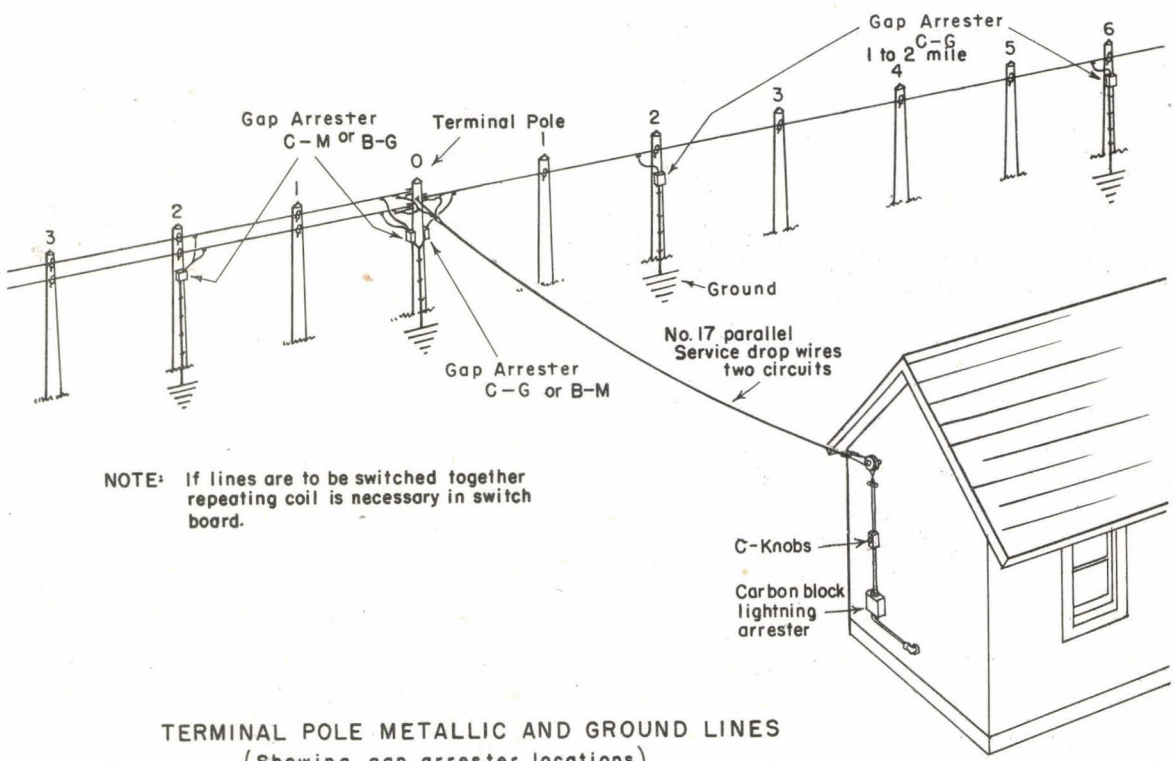
In heavy lightning zones, a single ball-gap arrester at the termination should not be expected to carry a full charge effectively. In such zones additional gap-type arresters should be installed on the second pole or support away from the terminal arrester and another on a pole approximately 1-2 milesfrom the terminal. The exact location of this remote arrester is not critical and its precise location is often controlled by availability of a good ground. The ground resistance for this arrester must be as low or lower than the ground resistance of the terminal gaps and should preferably not exceed 25 ohms.

Gap-type arresters should never be installed on buildings.

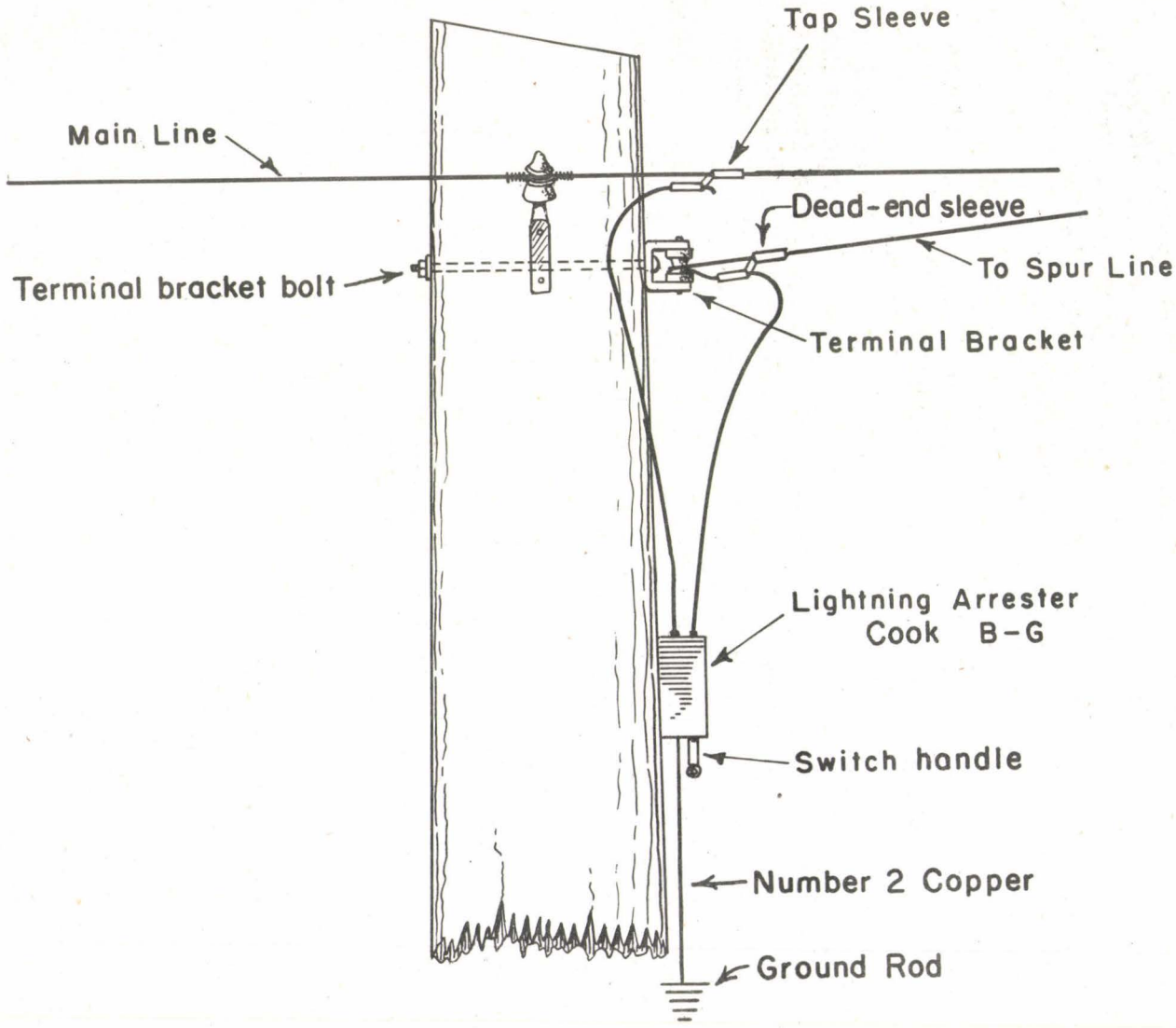
170. Grounding Conductor for Gap Arresters

Large gauge (No. 2 soft copper) conductor wire is needed to carry the heavy currents present during arrester operation. This same conductor should extend above the pole 4 inches to provide a point of contact above the line wires for grounding direct strikes.

Where several gap arresters are installed on the same pole a common lead to ground is satisfactory.

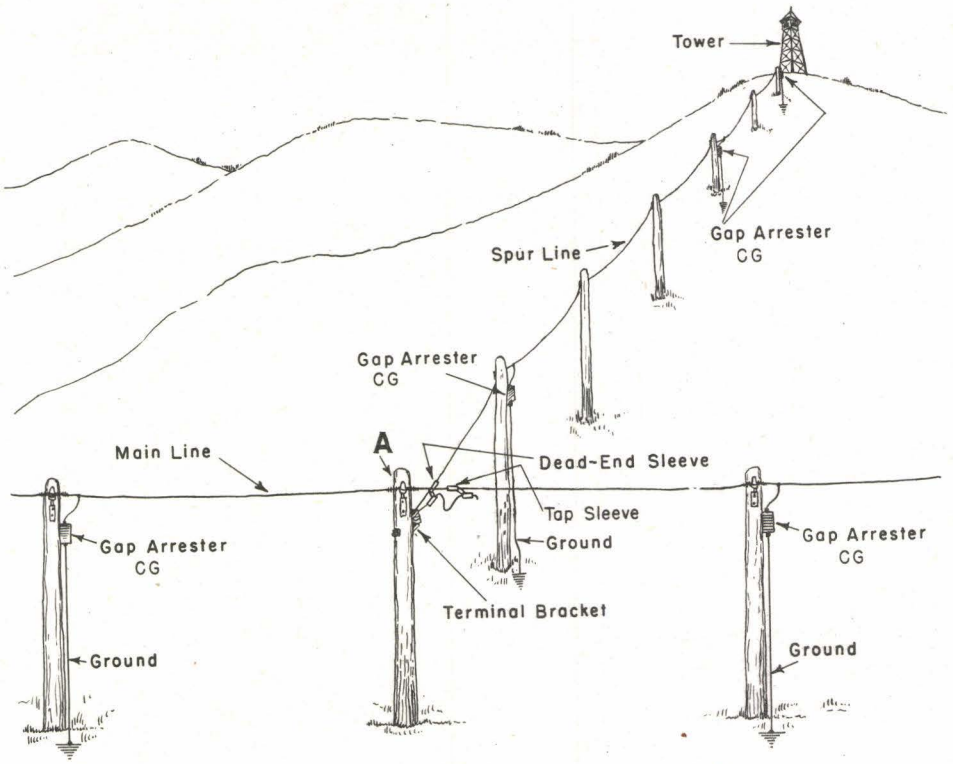


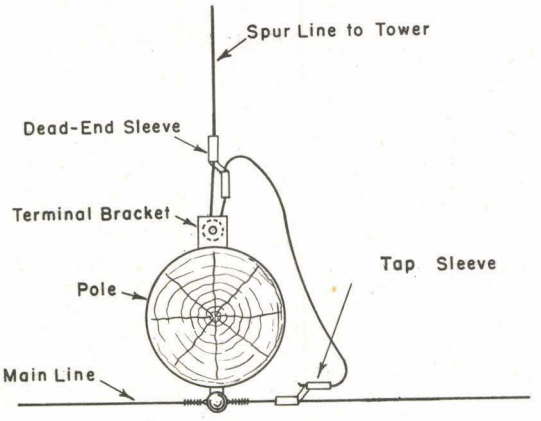
TERMINAL POLE METALLIC AND GROUND LINES
(Showing gap arrester locations)



SPUR LINE JUNCTION POLE — WITH GAP ARRESTER AND CUT — OFF SWITCH

A telephone line leading to, or along a ridge, is subjected to more lightning attraction than is a line located in a valley. Added protection should be given to line so located, especially to span, where they connect to the main line. Gap arresters should be used on the first poles or tie trees each side of the connection. Where possible spur lines should be disconnected from the main line during periods of non-use.





DETAIL OF **A**

LIGHTNING PROTECTION FOR SPUR LINE GROUND CIRCUIT

(Use same method for metallic circuit)

171. Grounds for Gap Arresters

The heavy current associated with gap-arrester operation requires grounds capable of carrying the current. Copper-covered ground rods with clamp is standard for this purpose. A ground rod is standard. All gap-arrester grounds should be measured. See ground table page 200.

Where a sufficiently low ground resistance cannot be secured without extending the ground wire beyond the immediate vicinity of the pole the #2 bare copper wire must be laid underground until it clears the improved or landscaped area. After which it may be reduced to #10 AWG copper-covered steel wire and constructed by open wire with or without insulators to the selected ground. Depth of trench is not important except to the extent necessary to protect the wire from physical damage.

In case of the remote gap arrester discussed above an extended ground should be avoided if at all possible to secure a low resistance without extension.

172. Carbon Block-type Arresters

The purpose of this unit is to handle small charges that will not jump across the gap-type arrester and to further reduce the charge on the line during the interval of gap-arrester operation. It is limited in current carrying capacity and is not a substitute for gap-type arresters.

This arrester will also drain to ground currents caused by contacts with low-voltage power lines. (See fuses)

The very close spacing (.003 to .006 inches) of the gap may require cleaning following operation caused by an electrical storm. The unit must also be housed in a tight compartment to reduce dirt deposits and accumulations due to insects. Since this unit can cause a line to become inoperative or rendered less effective due to breakdown, it should not be used at unattended stations on lines where continuity of service is required.

The ground lead to such arresters should be kept as short as possible and the ground resistance should not exceed 100 ohms. (See gap arresters for extended grounds)

Carbon block-type arresters are standard for installation at:

(a) Attended Stations

(1) At the junction between open wire lines and cable systems other than the drop-wire types. (To be used in addition to the gap-type arrester).

(2) At all junction boxes at the point where cable or dropwire leads enter a building.

(b) Unattended Stations

(1) Same as above except disconnect switch must be provided to remove carbon-block arrester wiring and telephone from the line during periods when the station is not occupied.

The Reliable No. 402-S Outdoor Arrester, equipped with 2 number P-495 self-cleaning saw-tooth discharge blocks and 2 number P-1384 carbon blocks, without fuses. For use at installations where line is not exposed to power lines.

The Cook number 1 Outdoor Arrester equipped with 2 number 4500 True Gap discharge blocks and 2 number 2080 carbon blocks. For use at installations where line is not exposed to power lines.

173. Vacuum-type Arresters (See drawing page 300)

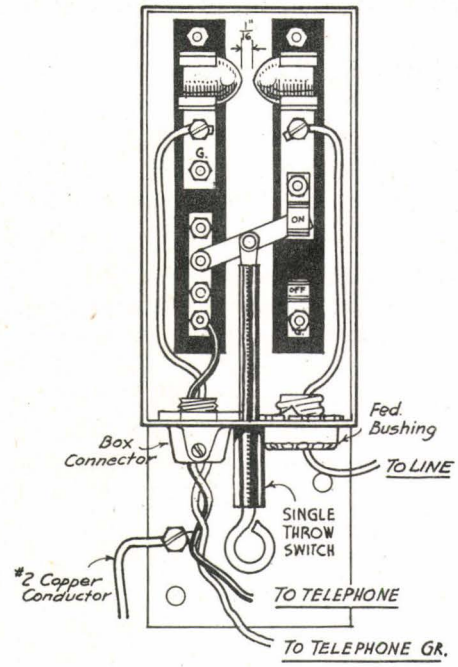
The vacuum-type arrester is not an efficient protector because of its delay in discharging. Its use should be confined to unattended installations, such as repeating coils, and then only where standard ball gap (CM or CG) arresters are used on pole with repeating coil and on second pole each side of the repeating coil. (See Repeating coil installation drawing). Fuses should not be used with vacuum arresters. Where power line exposure is a possibility, use the 99-A Protector.

174. Grounding-Type Disconnect Switches

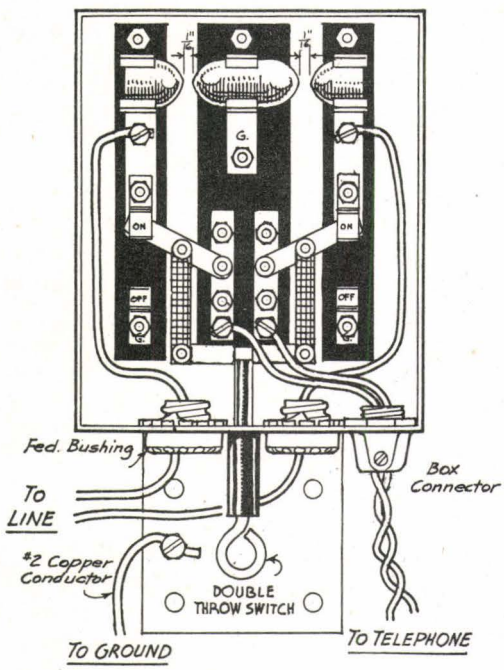
This device is for the purpose of disconnecting the telephone and associate wiring from the line and grounding the instrument and wiring leaving only the gap-type arrester connected to the line. There are reasons for disconnecting and grounding such installations:

(a) To reduce the electrical load on the line during periods when service at the installation is not required.

(b) To provide the maximum protection to equipment and operator from severe local lightning storms in the vicinity. Switches should be so arranged that operation of the switch can be accomplished by the operator without leaving the protective area within the lightning cage. (See details on page 211.

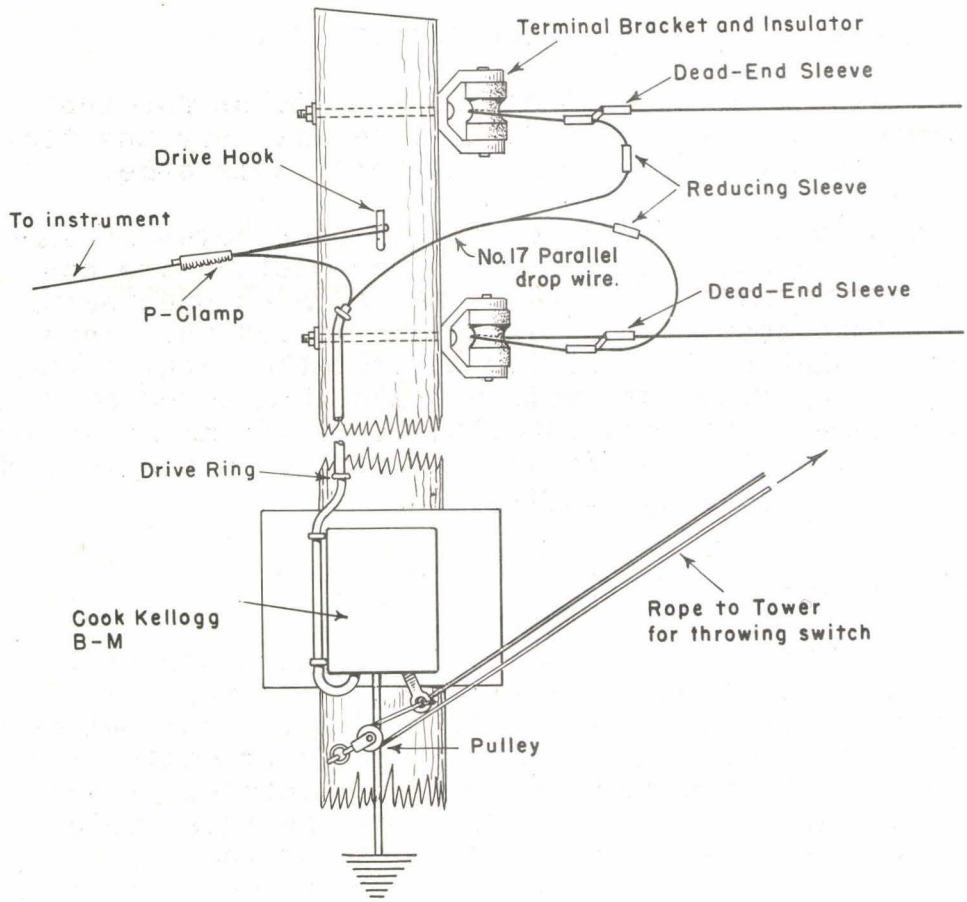


COOK-KELLOGG B-M
(GROUNDED CIRCUIT)
(Insect Proof)



COOK-KELLOGG B-G
(METALLIC CIRCUIT)
(Insect Proof)

TYPE B LIGHTNING ARRESTERS



LIGHTNING-ARRESTER SWITCH TERMINAL POLE

REMOTELY CONTROLLED FROM TOWER CAB.

(c) To remove from the line such equipment as the telephone instrument, wiring and carbon block or other low-voltage arresters that could become defective due to lightning or other sources during periods when the station is not occupied.

The following locations require the installation of grounding disconnect switches (types BG for ground return circuits and BM for metallic circuits.

(d) At all towers, observations, guard stations, residences and similar installations not continuously occupied.

(e) At permanently installed field telephones the ground for a disconnect switch should not have a greater resistance than any other ground within a radius of 400 feet. Use same ground as for telephone and lightning cage at lookout points.

174-A. Line and Instrument Disconnects

Past experience has proven that knife switches for test stations and disconnects along the line are very unsatisfactory due to the variations in contact resistance.

For test stations, bridging connectors or sleeves as shown on page 165 are adequate. Bridging connectors are not satisfactory for most line switching, such as stub sections, since tools are required to tighten or loosen the connectors. A special insulated block having connectable links tightly held in place by wing nuts will provide the needed convenience and secure low-resistance contacts. There is no known standard device suitable for this application but a simple link connector can be made up locally.

174-B. Line Fuses

Fuses are for the purpose of opening the line circuit, should an actual contact with power circuits accidentally occur. Fusing is primarily to avoid starting fires should wires and fixtures become overheated. Fuses offer practically no protection to operating personnel against electrical shock. They may actually increase the hazards since the fuse opens the circuit there is no grounding effect and if the line is touched, the full voltage would be encountered.(See Page 204 for Method)

Line fusing is required on theselines where an accidental electrical contact with power circuits can occur. Fuses should not be installed in other lines.

In the case of a metallic circuit, exposed to accidental contact with power, connected through a standard repeat coil to a ground return line not exposed to power contact, it will not be necessary to fuse the instruments on the ground line section.

Carbon-block type arresters are always required to be used with line fuses to provide the path for current needed to cause the fuse to operate. The fuses will be placed in the line between the carbon-block arrester and the exposed section of the line. Under certain conditions lightning may cause fuses to blow. For this reason, avoid line fuses in remote or unattended stations where uninterrupted service is required.

175. Insulating and Drainage Transformers

Where metallic lines have long parallel exposures to high voltage transmission lines, insulating transformers should be used to isolate the exposed section. Without insulating transformers a real hazard exists when faults such as short circuits or grounds occur on the power system. This

problem is too technical to set up definite standards that will be applicable in all cases. Special consideration should be given to the use of insulating transformers when the telephone line closely parallels power transmission lines of 60,000 volts or over, for a distance of 10 miles or more. The assistance of the engineering department of the power agency and the telephone company in the area should be solicited in determining whether the line should have such protection.

176. Protector #99-A

The 99-A Protector consists of a 3000 volt gap which is mounted in a cylindrical galvanized housing approximately 2 1/2 inches in diameter and height. It is self-clearing and generally no maintenance should be required as a result of normal operation.

(a) Purpose

The purpose of the 99-A protector is to limit to a value less than the capacity of the statior or installation protector, the voltage that may be impressed on the telephone circuit in the event of a power contact with open wire circuits on jointly used poles carrying higher voltage supply.

(b) Where to Use

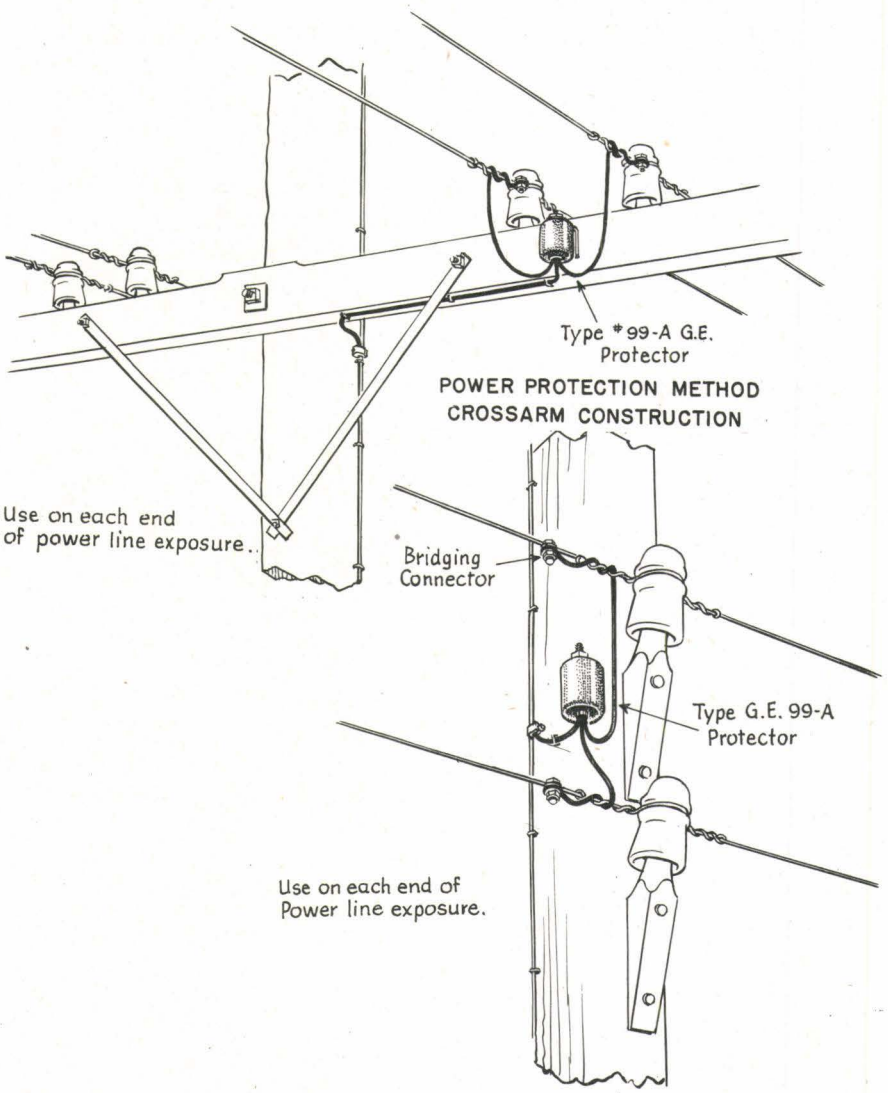
The 99-A protector should be installed at the junction of the drop wires, buried wire or service cable and the open wire circuits involved in the higher voltage exposure or at the ends of open wire sections on jointly used poles.

(c) Installation

Locate the 99-A protector on the side of the crossarm, or pole for bracket line, midway between the pins or brackets of the circuit involved. For the pole pair, locate the protector on the side of the crossarm just outside of the pin adjacent to the point at which the service wires are separated for the run to the open wire. The protector should be located preferably on the opposite side of the crossarm from the service connection to the open wire, with the top of the housing slightly below the top of the crossarm. See drawing on page 214

(d) Protector Ground

A good ground is necessary and should not under any circumstances be made in the power space on the pole. Resistance not greater than 100 ohms should be used for all ground connections.


Type #99-A G.E. Protector
POWER PROTECTION METHOD
CROSSARM CONSTRUCTION
Use on each end of power line exposure.
Bridging Connector
Type G.E. 99-A Protector
Use on each end of Power line exposure.

POWER PROTECTOR METHOD
Bracket Construction

The Reliable number 1000 Outdoor Protector equipped with 2 P-495 saw-tooth, self-cleaning discharge blocks and 2 P-197 carbon blocks and 2 number 55, 7 amp. fuses for use at installations where conductor wires are exposed to power transmission lines.

177. Line Loading

The efficiency of any telephone circuit, ground return or metallic, is largely determined by its loading. That is, each mile of wire, each instrument, each repeating coil, and other auxillary equipment attached to a telephone circuit adds to the lineload. In addition any contact the wires make with any object not properly insulated, like brush, tree, buildings, cracked insulators or no insulators power line induction etc., increases this same load. It has been determined that the top load a circuit can carry is 31 decibles (a unit of sound measurement). However if the circuit is loaded to this extent by length and instruments, it will invariably be overloaded by foreign objects poor splices, leaks, and insulators. Therefore it is best to plan the circuit, for an instrument and wire load not to exceed 20 db. Then the load that is accidently placed on the circuit can be carried usually without impairment of the transmission and receiving levels. Where it is necessary to load a line more than 20 dbs. necessary tests should be made to locate any foreign load on the circuit and in no case should the load exceed 31 db. both foreign and instrument.

The following table of decibel ratings should be used for determining loads of both wire and instruments.

Parts of the Telephone Circuit		Average Db. Load
Wire #9 EBB	Ground return system	.15 (Per loop mile)
Wire #9 EBB	Metallic System	.25 (Per loop mile)
Wire #12 AWG Copper-covered 40%	Ground return system	.14 (Per loop mile)
Wire #12 AWG Copper-covered 40%	Metallic System	.22 (Per loop mile)
Wire #10 AWG Copper-covered 40%	Metallic System	.15 (Per loop mile)
Wire #8 AWG Copper-covered 40%	Metallic system	.11 (Per loop mile)
Wire #6 AWG Copper-covered 40%	Metallic system	.08 (Per loop mile)
Wire #10 B&S Copper	Metallic System	.08 (Per loop mile)
Wire #8 B&S Copper	Metallic System	.06 (Per loop mile)
Ringer 2500 ohm		1.00
Repeating Coils		0.50
Howlers		0.65
Spur Lines		1.00 plus wire length load

178. Wire

Longitudinal Balance on Metallic Lines. -- Satisfactory noise reduction cannot be consistently attained if the transmission characteristic of one wire in a circuit differs from the characteristic of the other wire. It is, therefore, important that both wires (and in the case of phantom groups that all four wires) be of equal material, gauge and state of deterioration.

179. Galvanized Iron - No. 9 E.B.B.

Standard for:

(a) Ground return line extensions where line to be extended is No. 9E.B.B.

(b) On metallic lines where longitudinal balance, equalized stresses and sags demand its use. Other agencies may require No. 9 when used on their pin space.

This wire is not suitable in areas where acid fumes, salt air or other corrosive vapors exist. Premature deterioration of the galvanized protective coating will result. Neither is it suitable for long span construction (See "Copper-covered Wire")

180. Solid Hard Drawn Copper Wire

Standard for: Metallic lines only.

Solid copper wire will be used only where:

(a) The overall system requires that certain long trunk lines or sections of lines contribute an exceptionally low transmission loss which cannot be met through the use of copper-covered steel wire.

(b) Use is specified by another agency from whom crossarm space is being secured.

The relatively low breaking strength of solid copper wire makes it generally unsatisfactory in heavy loading areas and in sections where frequent damage from falling timber

or other such hazards exist.

Strict initial compliance to sag tables and frequent checks on sags is necessary to avoid abnormal breakage and permanent elongation of this conductor.

181. Copper-covered Steel Wire

Standard for: Ground return lines except: See No. 9 EBB

All metallic lines except

(a) Where the line is an addition to an existing system using other material (See general consideration)

(b) Where exceptionally low transmission loss is essential and can only be obtained by use of solid copper wire.

Long spans in ground return lines. The greater strength and elasticity of copper-covered wire makes it especially adapted to the long-span construction.

Ground return lines of long length. Where topography permits and better transmission is required copper-covered wire of #12 AWS or larger may be specified.

Selection of gauges:

#12 for use on short metallic stubs or sections where transmission loss is not a factor, and for ground return lines.

#10 for use on the majority of metallic lines.

#8 for long-span construction (metallic or grounded). For use on long-grounded lines as stated above.

#6 for use in extra heavy loading areas and for long spans exceeding 750' when loading medium to heavy.

SWITCHBOARDS

182. General

As of the date of preparation of this material (April 1947) need exists for a standard Forest Service switchboard capable of meeting the varied demands of local switching problems and a variety of physical installation requirements.

Until such time as a study is made and design completed for a reliable and flexible board the Regions should, insofar as practicable, use standard commercially built equipment in the interest of minimizing the number of types in each area.

Much of the trouble encountered in the past in switchboards can be attributed to inadequate lightning protection and many inherently good boards have been condemned for this reason.

An amendment covering materials, Construction Standards and Methods will be issued upon completion of the investigation of standardization of switchboards.

TELEPHONE INSTRUMENTS

183. General

The instruments listed, and illustrations given, will serve as a guide to the standardization of Forest Service telephone instruments. The makes and model numbers listed do not comprise a complete list of instruments (old list retained in materials section) satisfactory for Forest Service use, neither does it give complete specifications for these instruments. It is suggested that within a given Region the number of makes of each type instrument be kept to a minimum, as a means of standardization and to reduce the number of stock items needed for repair.

TELEPHONE INSTRUMENTS

Type	Suggested Uses
Long Wall	Where space is not limited and it is desirable to have batteries in same case with instrument. If handset desired order special with regular transmitter and receiver replaced by handset. (Similar to Western Electric 1417-S or Kellogg #F-4886)
Short Wall or "Grabaphone"	Where wall or stand mounting is desired in limited space and it is not necessary to obtain maximum convenience for the user, such as a dwelling, small warehouse, repair shop, guard station, tower, and towerman residence. (Similar to Kellog 5880-M)
Desk - Type with handset and cradle mounting	Where handset is desired on desk or table for convenience of user - such as a ranger's office - warehouse office, and in some types of towers. May be used as extension phone or switchboard or equipped with bell and generator box. (Similar to Western Electric 250AW-3 and 300N Box.)
Desk - Type with handset mounting hanger	Where the features of a desk phone are desired but desk stand is not desired. Where an extension handset only is desired. In small tower cabs where the handset must be located overhead and separate bell and generator box used. (Instruments same as above)
Portable Field Telephone	Where an instrument packaged for easy carrying, light weight and quick connecting to line is necessary, such as scouts, patrol cars, fire camp cache. For any temporary or emergency use. (Similar to Kellogg #3001 or Signal Corps Model EE-8)
Mine Type	Where an instrument is needed outside of a building or tower, such as line intersection in remote areas, checking stations, rock quarries, etc. (Similar to Western Electric #1336-J)
Test Set	Used by district or forest "trouble shooter" to aid in locating trouble on lines. Will also serve as portable telephone if ringer is not needed. (West Type)

184. Power Ringing Equipment

Where commercial power is available, power ringing equipment may be used at principal switching centers.

Power ringing equipment merely replaces the hand-driven generator. The use of such equipment provides ringing voltage merely by the operation of a switch. This feature is useful in expediting the operation of a busy switchboard.

Power ringing equipment for converting 105-120 volt commercial power to 20 cycle ringing power should be of the type having no movable parts, such as the "Sub-Cycle Ringing Converter" Model "S".

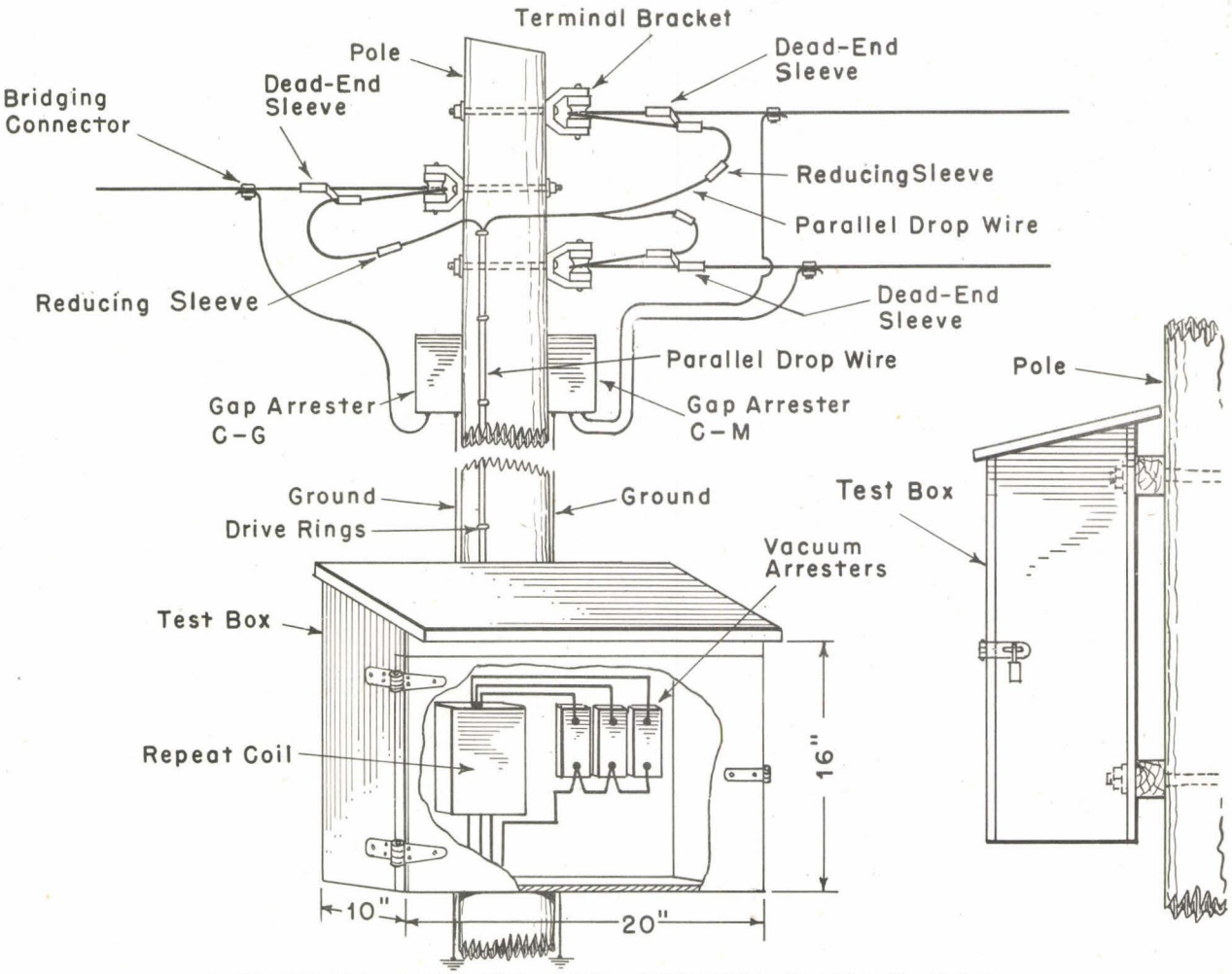
185. Centralized Repair of Telephone Equipment

Centralized telephone instrument and associated equipment repair has many advantages over such repair work done in the field. Shops are usually located in connection with radio repair shops and have available the necessary instruments for testing, tools for repairing, and technical supervision. In addition the over-all investment in repair parts is reduced by centralization and the purchasing and warehousing is simplified. However, the success of centralized repair depends largely on the cooperation of administrative officers in promptly forwarding defective instruments to the shop and in maintaining an adequate stock of replacement instruments on each ranger district or administrative unit. The stock of replacement instruments should be approximately 10% of the number of installed instruments.

186. Repeating Coils

These coils should be used at all points where it is desirable to connect a ground return circuit with a metallic circuit. This defination includes those parts of a ground return circuit which are being converted to metallic circuits because of interference. A repeating coil is required at each end where ground return and metallic circuits are to be connected. Unless well protected from lightning repeating coils will be a source of constant trouble. See protection chapter. Good grounds are also an essential not only for protection but also for the efficiency of the repeating coil itself.

It is considered advisable that repeating coils be mounted in the box container and completely wired by a technician with arresters as a unit. The only field work then necessary to change a repeating coil would be to dismount the old coil box, disconnect the connecting wires outside of the box and replace the old box containing the coil unit with a new one. The wires, line and ground extending outside of the box should be long enough to use reducing sleeves for connecting to the main line wires.



MOUNTING METHOD FOR REMOTE REPEAT COIL

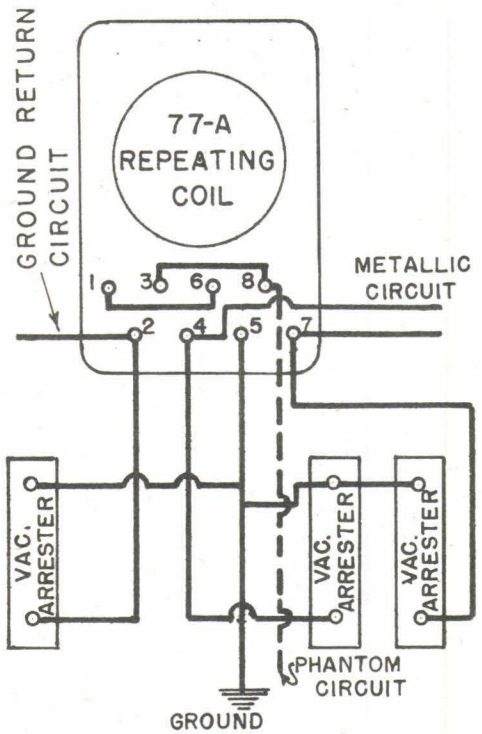
For clarity all wires have been shown with more slack than is needed in actual construction

187. Tests - Repeating Coils

Because of the uneven loads to which repeating coils are subjected they often lose their efficiency. Annual tests should be made of all repeating coils and those testing defective or slightly so, should be removed and sent to the shop for repairs. All repeating coils should be tested before installation. Tests to determine if coil is open or shorted should follow along the following steps for Graybar #77A or Kellogg #24A.

(a) Disconnect, with soldering iron, the 4 wire connections, the two metallic circuit wires, the ground return wire and the wire extending to the earth (ground), leave connected the two small jumper wires which connect the sections of the coil together.

(b) Connect ohmmeter clip leads to terminals #4 and #5. If the coil working at top efficiency the meter reading will be approximately 50 ohms for the Kellogg 24A and approximately 40 ohms for the Graybar 77A. If the meter reading is higher than these approximate figures the coil can be considered as open if the readings are less the coils can be considered as "shorted". In either case the repeating coil should be replaced.



WIRING FOR REPEATING COIL CONNECTION

(c) Connect the ohmmeter clip leads to terminals #4 and #7. The meter should read approximately 41 ohms on either the Kellogg or Graybar. Readings higher or lower indicates the same conditions as in (b).

(d) Set the ohmmeter for the highest ohm scale, then connect clip leads to terminals #2 and #7, if there is any indication on the meter the primary secondary

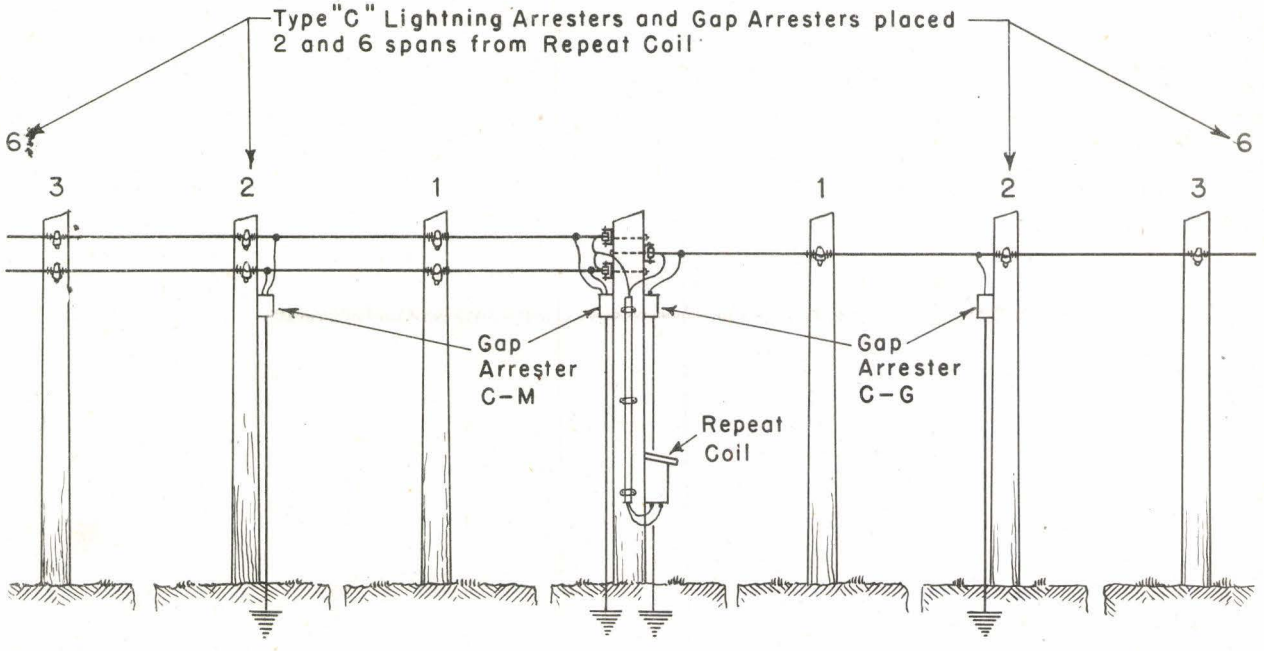
coils are shorted together. The repeating coil should be replaced.

The same tests can be made approximate by using two telephones in place of the ohmmeter as follows:

(e) Disconnect wires as in (a) above and connect the two line wires from one of the telephones to terminal #2 and #5 and the line wires from the second telephone to terminals #4 and #7. Now turn the crank of one of the phones. If the bells of the other phone rings strongly it is an indication the repeating coil is working. If not replacement of the coil is indicated.

188. Methods of Testing Repeating Coils Before Placing In Service

Use the same methods given in Section 187 when using an ohmmeter or two telephone instruments.



REPEAT COIL LIGHTNING PROTECTION

(b) Comparison Method

Connect the telephone line terminals by means of slip leads to terminals #2 and #5 on the repeating coil, then connect coil terminals #4 and #7 to a telephone line (one known to be in operating condition). Now make a call to some party on the line. Have the party record the volume of both the ringer and your voice. Then disconnect this coil and wire the one to be tested in the same manner and again ring and talk to the same party. If there appears no noticable difference it is reasonable to believe the coil is O.K. Of course if the ring does not go through it can be assumed the coil is defective.

The equipment needed for making the above tests are for ohmmeter test:

1 Ohmmeter - comparable to the Simpson Model #260.
2 Test leads, with small clips.
1 Iron, soldering and supply rosin core solder for the telephone test.
2 Telephones, portable preferred.
1 Iron, soldering and supply of rosin core solder.
4 Test leads, with clips for each, same equipment for the comparison test except a known workable repeating coil should be available in addition to the coil to be tested.

Often, as with the voice and ringing circuits of a telephone system the trouble may be found not in the instrument itself, but in some of its accessory equipment. In the case of an apparent failure of a repeating coil it is a good practice to test the ground, determine the resistance from the ground post of the repeating coil to the final ground connection. If the resistance is within the prescribed limits (25-50 ohms) the trouble must be in the coil itself.

In a case where a repeating coil has failed, the ground resistance should be checked before installing a new coil. Usually, most failures of repeating coils can be attributed to lack of lightning protection and long service. All repeating coil lightning protection should be in accordance with the drawings shown on pages 221, 222, 223. It is not necessary to establish separate grounds for the repeating coil and the protective system, except for those protection grounds removed some distance from repeating coil.

189. Tests - Transmission

It is suggested that each Region have at least one transmitting test set available for testing transmission efficiency. These sets send out a known level signal on a circuit to another point where it is measured by a companion set. The difference indicates loss or degree of line efficiency. Such a test should be made of all lines at least once each year with all required telephone instruments and associated equipment on the line.

Transmitting test sets (Shall Cross) operated by AC power available from Kellogg or Automatic Electric. The army has a test set of high quality 1-61-C which may be available on surplus lists. This set is battery operated and is ideal for the Forest Service.

190. Batteries (Dry Cells 1 1/2 volt)

Batteries should be replaced once each year regardless of use. Each battery should be dated when put into service and tested. A new battery should test 35 amperes. When a battery tests 10 amperes it is about exhausted and should be replaced even though it can still operate the phone. The next day it may fail. Battery procurement should be adjusted to the number of phones in use in order not to have a large supply left over to become exhausted from shelf life. All batteries should be tested before being placed in service especially in remote stations. An extra pair of batteries at such stations, if important, may be wise.

Batteries should be stored in a dry, cool storage compartment. Care should be exercised to prevent battery terminals from contacting any metal object. Dampness starts a corrosive action.

Batteries which have a shelf-life of 10 - 12 months may fail during a critical period. Use such batteries, if any, in phones, located where replacement is relatively quick, such as in phones around a warehouse plant, or in those phones where a supply of extra batteries can be made available.

MATERIALS

190. General

This chapter on materials has been written to assure a uniform communication system through the use of the proper types and kinds of material and to effect economy through centralized purchase and storage. Some of the items listed will be purchased Service-wide and shipped direct from the factories to the regions. Other items which do not justify central purchase, because of the small quantity will be purchased and stocked by the Regions.

The selections of the materials listed in this chapter were made sufficiently broad to enable compliance but still meet the demands of construction and maintenance standards. Substitutes are not authorized except in extreme emergencies. When need is found, and can be justified, for types or kinds of material not listed herein, clearance will first be secured for their use from the Chief. Items thus approved will be added to this chapter as an amendment.

Surplus materials available for transfer from other agencies or surplus Forest Service stocks, which do not comply with the material list, fall within the category of substitutes.

Where manufacturers names have been used in the materials list it is to be understood that the named product or equal is acceptable. Manufacturers names are used primarily for the purpose of identification of the device or part in commercial catalogs.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Anchors, Cone, 6"	Anchors for guy wires	Chance Pyramid or equal
Anchors, Steelwing, 6" x 69" Thimbleye, no wrench or equal.	Anchors for guy wires	Hubbard and Company
Anchors, log and plank 6' rod, same as cone type rod.	Anchors for guy wires	Made in Ranger District
Anchors, rock.		Hubbard and Company
Arresters, (See "Protection Devices"),		
Bands, hot galvanized, #12 gauge, 2" x 68½", #7850. (See page	Stubbing reinforcement	Hubbard and Company
Bands, hot galvanized, #12 gauge, 2" x 89½", #7851 or equal.	Stubbing reinforcement	Hubbard and Company
Battery, dry cell, #6 Federal Specifications WB-101 ("Telephone type").	Telephone battery	Graybar
Bell, extension, 2500 ohm ringer, with 3" gong, Western Electric No. 127-F, Kellogg No. 37-SG or equal	Extension bells	Western Electric Co. Kellogg Switchboard & Supply Co.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Bell, extension, 2500 ohm ringer, with 6" gong, Western Electric No. 392-B, Kellogg No. 65-SG or equal.	Extension bells	Western Electric Co. Kellogg Switchboard & Supply Co.
Block, connecting type K, Automatic Electric.	Switchboards, Inside terminals, etc.,	Automatic Electric
Block, connecting type 41 - Automatic Electric.	For instrument cord terminal	Automatic Electric
Bolt, carriage, 3/8" x 4", not galvanized.	Crossarm brace	Hubbard and Company
Bolt, carriage 3/8" x 4½"	Maintaining back truss	Hubbard and Company
Bolts, machine, hot galvanized:	Crossarm & stubbing	
#9704 - 1/2" x 4-1/2"	Crossarm & stubbing	Hubbard and Company
#9706 - 1/2" x 6"	Crossarm & stubbing	Hubbard and Company
#9806 - 5/8" x 6"	Crossarm & stubbing	Hubbard and Company
#9808 - 5/8" x 8"	Crossarm & stubbing	Hubbard and Company
#9810 - 5/8" x 10"	Crossarm & stubbing	Hubbard and Company
*#9812 - 5/8" x 12"	Crossarm & stubbing	Hubbard and Company
*#9814 - 5/8" x 14"	Crossarm & stubbing	Hubbard and Company
*#9816 - 5/8" x 16"	Crossarm & stubbing	Hubbard and Company
*#9818 - 5/8" x 18"	Crossarm & stubbing	Hubbard and Company
*Galvanized iron with rolled thread, supplied with nuts but no washers.		

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
*Bolt, double arming, #9864, 5/8" x 14", galvanized iron, threaded full length, supplied with four nuts.	For spacing double arms	Hubbard and Company
*Bolt, double arming, #9866, 5/8" x 16", galvanized iron threaded full length, supplied with 4 nuts.	For spacing double arms	Hubbard and Company
*Bolt, double arming, #9868, 5/8" x 18", galvanized iron threaded full length, supplied with 4 nuts.	For spacing double arms	Hubbard and Company
Bolt, guyeye (straight), galvanized iron - roll thread - supplied with nut: #9058 - 5/8" x 8" #9060 - 5/8" x 10" #9062 - 5/8" x 12" #9064 - 5/8" x 14" #9066 - 5/8" x 16"	For attachment of messenger cables and overhead guys.	Hubbard and Company
Bolteye, #9958, 5/8" x 8", galvanized iron, roll thread.	For deadends	Hubbard and Company

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Bolt, #9960, 5/8" x 10", galvanized iron, roll thread	For deadends	Hubbard and Company
Box, dry cell battery, for 3 cells, #1-A or equal.	For holding batteries while in use	Western Electric
Box, desk set, 5 bar magneto 2500 ohm ringer, Kellogg #F-2371; Western Electric #300-N, or equal	Telephone ringer box	Kellogg Switchboard & Supply Co. Western Electric
Bushing, Federal, A-2 type, 1/2" size.	For insulating entrance to lightning arrester and terminal boxes.	Graybar Electric Co.
Bushing, Wood, reducing, 9/16" ID x 1-3/16" OD x 4".	For reducing size of pin hole in crossarm when steel pins are to be used	Graybar Electric Co.
Brace, Crossarm, #8030, 7/32" x 1-7/32" x 30" hot galvanized.	Crossarm brace	Hubbard and Company
Brace, Diagonal, #8050, 2 x 2 x 3/16 angle iron 83" long, with step - hot galvanized.	Alley arm brace	Hubbard and Company
Brace, vertical, #8054, 1-3/4 x 1-3/4 x 1/4 angle, 30-5/8" long, hot galvanized,	Alley arm	Hubbard and Company

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Brackets, wood, type #6 WU. 2" x 2-3/8" x 12" oak.		Graybar Electric Co. Automatic Electric Co.
(When purchasing wood brackets for use in Regions where wood decays rapidly, specify brackets to be hot dipped in creosote oil).	For line insulator attachment	
Bracket, terminal with bolt.	For deadending	A. B. Chance
Bracket, phantom transposition, #9275 (Pins and mounting bolts and nuts included with bracket).	Phantom transposition	Hubbard and Company
Bracket, terminal, with bolt.	Terminal Bracket	A. B. Chance Automatic Electric
Bracket, R1	transposition	Hubbard and Company
Bracket,	House wire distributing House wire distributing	Automatic Electric Co. Graybar Electric Co.
Bracket,	Corner house wire distributing	Automatic Electric Co. Graybar Electric Co
Cable - (See Wire)		
Clamp, P, Drop wire,	For entrance construction	Graybar Electric Co.

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Clamp, ground, range type, heavy duty.	For grounding to water pipes	Graybar Electric Co.
Clamp, guy, #7449, 3 bolt for 5/16" strand.	For clamping all guy and messenger stands	Hubbard and Company
Clamp, Span #8917.	For attachment of drop wire clamps to messenger cable at points in mid-span.	Hubbard and Company
Clamp, pole stubbing		Automatic Electric
Clamp, Cable suspension	For clamping 1/4" - 7/16" messenger strand to pole	Hubbard and Company
Clevis, Hubbard #805	To be assembled with Hubbard #7502 eyenut and #502 strain insulator for long spans.	Hubbard and Company
Clip, bracket, #14 gauge, iron, 2" x 1" x 1/2" with 5/16" hole.	For use in preventing bracket splitting	Graybar Electric Co. Automatic Electric
Clip, S wire	For house runs	Graybar Electric Co.
Coil, repeating, Kellogg, #21-A, and #24-A;Western Electric #77-A	For connecting metallic and ground return lines together	Kellogg Switchboard & Supply Co. Western Electric
Coil, induction, #13 Western, #100 Kellogg.	For telephone instrument	Kellogg Switchboard & Supply Co. Western Electric

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Cord, telephone, all kinds.	For telephone transmitter and receiver.	Western Electric Co.
Cord, test set, all kinds.	For instrument use	Western Electric Co.
Connector Bridging, copper or copper covered steel, Wire Size — Catalog No. #6 AWG — 6F #8 AWG — 128V #9-12 B&S — 9F	For test stations and connecting gap arresters to telephone lines	Reliable Electric Co.
Connector Bridging, galvanized iron, #9 BWG — 165G #12 BWG — 109	For test stations and connecting gap arresters to telephone lines	Reliable Electric Co.
Connector Bridging, for combination of copper and galvanized iron: #9 BWB Galv. iron to #6 AWF Copper or smaller — 165 GC #12 BWG Galv. iron to #9 AWG Copper or smaller — 109 W	For test stations and connecting gap arresters to telephone lines	Reliable Electric Co.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Conduit, galvanized iron.	For laying wire underground	Graybar Electric Co.
Condenser, 1/4 Mf., WE #21-4	For telephone instrument	Graybar Electric Co.
Condenser, 1 Mf., WE #149-E	For telephone instrument	Graybar Electric Co.
Connecting Block, Type K	For inside terminal switchboards, etc.	Graybar Electric Co.
Connecting Block, Type 41	For instrument cord terminal	Graybar Electric Co.
Crossarms, (See table below)		Graybar Electric Co. Automatic Electric Co.

Crossarms

Number of Pins	Length of Crossarm in Inches	Size of Crossarm in Inches	Size of Hole For Metal Pin	Center Bolt Hole	Crossarm Brace Hole	Distance of Brace Holes from Center	Pin Spacing			Length of Crossarm Brace in Inches
							Center Spacing	Side Spacing	End Spacing	
6	6	3½x4½	9/16	21/32	7/16	21"	16"*	12"*	4	30
10	10	3½x3½	9/16	21/32	7/16	21"	16"*	12"*	4	30
**10	6	4½x4½	9/16	21/32	7/16	21"	16"*	6"*	4	30

*For joint use poles, center spacing on crossarms should be 32" and side spacing 10".

**Special for terminals and reverse arms. See pages 89-91.

Crossarm Material. -

Douglas Fir and Southern Yellow Pine are both widely used for crossarm material. The mechanical strength of the arm is of prime importance and woods having less strength than the above should not be used. Specifications for Southern Yellow Pine should require arms to be free from shake, through checks, splits, pitch seams, cracks, rot, red heart, decayed knots or unsound knots. The grain should not deviate except at knots and pitch pockets more than 1" in 12". Sound knots should not exceed 1" in diameter nor should there be more than 1 knot in any 6" middle section of the arm. Pitch pockets should not be over 1 1/2" deep nor more than 1/8" in width or 8" long. Checks shall not be more than 1/2" deep in the top surface, nor more than 3/4" deep in the side or bottom surfaces. The length of such checks shall not exceed 12". Wane shall not appear on more than two edges of a crossarm nor closer than 1/4" from a pin hole. No insect damage in the middle half of the arm. Warp is permitted in only one direction and that not to exceed 1/10" for each foot of armlength. Specifications for Douglas Fir should require, in addition to the above, that not less than 8 annual rings per inch at each end of the arm except that arms having 33 1/3% summer wood may have not less than 6 rings. No loose heart nor heart centers and not more than 25% sap wood on any cross-section. No stain rot or decay.

Cross arms may be obtained with rounded tops for better drainage. There appears to be no advantage in this feature for pressure treated arms and should not be required. For untreated arms an advantage of rounded tops is apparent. Crossarms either treated or untreated should be carefully stacked while in storage to prevent warping.

Preservative Treatment. -

Southern Yellow Pine should be pressured-treated. Douglas Fir arms are not generally pressure-treated, but in very damp climates it is recommended. Untreated crossarms may be painted or stained if necessary for bettering appearances at Ranger Stations or at locations where asthetic considerations are important. Use prevailing Federal specifications for pressure treatment.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Eye,Bolt, #9958, 5/8" x 8", galvanized iron, roll thread.	For use in deadends, long spans, and bracket construction.	Hubbard and Company
Eye,Bolt, #9960, 5/8" x 10", galvanized iron, roll thread.	For use in deadends, long spans, and bracket construction.	Hubbard and Company
Eye, Nuts, #7660.	For deadends and guys.	Hubbard and Company
Federal, Bushing, A-2 type, 1/2" size.	For building entrance	Graybar Electric Co.
Friction tape	For insulation	Graybar Electric Co.
Glass insulators, glass, No. 16, Hemingray, square groove, 2-5/8" x 4".	For line wires	Hemingray
Glass insulator, glass, No. 43, Hemingray, with top groove, 3-3/4" x 4-9/32". (Too large for use on brackets).	For line wires	Hemingray
Glass insulator, glass #53, double groove, 4"x4½", Application: for use with R1 transposition system only.	For line wires	Hemingray

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Ground Rods, Copper-covered and accessories:		
Type Size		
#9435 Copper covered steel #9436 rod 5/8" x 5' or 6' standard pkg. 10 rods.	For telephone and Protection grounds	Hubbard and Company Automatic Electric
#29435 Copper covered steel #29436 sectional ground rod 5/8" x 5' or 6'	For telephone and Protection grounds	Hubbard and Company Automatic Electric
#9534 Sectional rod coupling 5/8" rod size	For telephone and Protection grounds	Hubbard and Company Automatic Electric
#29534 Driving stud	For driving sectional ground rods	
# 6592 Ground rod clamp,5/8"	For Connections to ground rods	Hubbard and Company Automatic Electric
*Guy Strand, 5/16", 7-strand, Siemans-Martin grade or equal. Rated min. breaking strength 5350 pounds, wire diameter 104, weight per 1000' - 205 pounds.	For guys and cable messenger	Automatic Electric

*Since Forest Service pole systems are seldom required to support more than a small number of attached lines and other fixtures, guying requirements can be met by the use of a single size of strand. In some instances the 5/16" strand may be larger than necessary for the stresses applied but for sake of reducing the number of types of hardware other sizes are not standardized.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Guy Rod, anchor guy, 5/8" x 6', Kellogg Thimbleye #J-7416; Hubbard Guyeye #8416; Graybar thimbleye #56, or equal.	For connecting guys to anchors.	Kellogg Switchboard & Supply Co. Hubbard and Company Graybar Electric Co.
Guy Rod, Anchor Guy, 3/4" x 6', hot galvanized, Kellogg Twineye #J-7526; Hubbard Tu-Guyeye #8526; Graybar Twineye #360, or equal	For attaching two guy strands to one anchor	Kellogg Switchboard & Supply Co. Hubbard and Company Graybar Electric Co.
Guy Clamp #7449, 3 bolt for 5/16" strand.	For clamping all guy and messenger strands	Hubbard and Company
Guyeye Bolt (Straight), galvanized iron, roll thread: #9058 5/8" x 8" #9060 5/8" x 10" #9062 5/8" x 12" #9064 5/8" x 14" #9066 5/8" x 16'	For connecting guys to poles	Hubbard and Company
Guard, Guy Strand	For protection to and from guys	Hubbard and Company Automatic Electric

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Hangers, cable, Davidson type: Type 1 — Length In. 7-7/8" — Max. Cable Space 3/4" Type 2 — Length In. 11" — Max. Cable Space 1-1/8" Type 3 — Length In. 14" — Max. Cable Space 1-5/8" Type 4 — Length In. 16" — Max. Cable Space 2"	For handing cable or wire on messenger	Reliable Electric Co.
Hooks, Drive, #1316,	For attachment of drop wire clips and clamps to poles.	Hubbard and Company
Hooks, Drop Wire, (Use 5/16" x 2½" lag screw or bolt, or 18 x 2 Round Head wood screw) (See Hooks Drop wire.)	Substitute for drive hook on some types of structures where drive hook would be unsatisfactory.	
Induction Coil #13, Western Electric, Graybar, 100-A Kellogg.	For telephone instrument	Graybar Electric Co. Kellogg Switchboard & Supply Co.
Insulators, Glass: #16, Hemingray, square groove, 2-5/8" x 4", Automatic Electric, #43, Hemingray, with top groove, 3-3/4" x 4-9/32", Automatic Elec. (too large for use on brackets) #53 Hemingray, square groove, 3/8" - 4" x 4 1/2" Automatic Electric.	For line wires Point tandem transposition	Automatic Electric Graybar Electric Co.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Insulators, Glass: #15 Whitall Tatum 3/8" - 3 7/8" x 4".	For point tandem transposition. For line wires.	Automatic Electric Graybar Electric Co.
Insulators, Tree, Split, Porcelain, Forest Service Specifications.	For tree lines	Central Purchase
Insulator, Type "C", split porcelain, screw attachment.	For entrance construction house runs	Automatic Electric
Insulator, Type "S", porcelain knob, single groove,	For entrance construction house runs	Automatic Electric
Insulator, type "T", porcelain knob, double groove	For entrance construction house runs	Automatic Electric
Insulator, Terminal	For entrance construction house runs	A. B. Chance
Loom, non-metallic conduit, commonly known as Flextude and Flexiduct.	For inside wiring	Graybar Electric Co. Automatic Electric
Line Wire (See Wire).		
Moulding, wood ground wire.	For protection from ground wire	Automatic Electric Co.
Nails, 30d, and 60d, galvanized, for attaching brackets.	For attaching brackets	
Nails, 6d box, galvanized.	For holding pins in cross-arms.	

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Nails, 5/8" inside wiring, with large head.	For wiring along moulding	Hardware Store
Nails, dating, blank head #21900 Hubbard, dated head #219 plus the year, Example: 1945-#21945.	For Pole Dating	Hubbard and Company
Nails, 4d, galvanized.	For attaching aluminum numbers and letters	
Numerals, pole, 1½" stamped	For pole numbering	Graybar Electric Co.
Nuts, Eye, 7660		Hubbard and Company
Pins, crossarm and transposition types:	For line insulators	Hubbard and Company
#974 Metal, long-shank, lead cob		
#8000 Metal, long-shank, wood		
** 1¾" x 8" wood, locust		
** 1½" x 9" wood, locust		
*#972 Metal, short-shank		
#975-P Metal, lag-screw type.		
*Use short shank pins on transposition brackets.		
**Order to fit crossarm pinhole		

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Plate, angle, manufactured from angle iron.	Angle bracket for tandem transposition	
Pipe, reinforcement, hot galvanized, 2" x 5", extra heavy, 1/2" galvanized.	Reinforcement stubbing bands	Hubbard and Company
*Poles, (See pp. 244-246.)		

*Poles. -

Full-length, pressure-treated Southern Yellow Pine, Northern White Cedar, and Douglas Fir are the accepted standard for permanent pole line construction. Certain other species which may be available locally can be used if full-length, pressure-treated and local experience indicates a normal life expectancy of 20 years or more.

Western Red Cedar, butt treated only, may be used if local climatic conditions are such as to result in long pole life above ground.

Split poles, especially cedar, should be avoided due to the climbing hazards involved.

Treatment. -

Poles should be treated both full length pressure and butt, according to prevailing Federal Specifications for "Wood Preservation and Treating Practice". (See Federal Standard Stock Catalog and USDA Wood Handbook).

Gains and holes cut after pole treatment should be generously brushed with hot creosote solution.

Roofing. -

A one-way or shed roof will be standard for all poles. Roofing should be cut at right angles to the gained face at an angle of approximately 1/4 the diameter of the pole.

Gains and Bolt Holes. -

Gains, slab type, on one side of pole is standard. They should be cut 3/8" deep and 3' 6" long down from the top of the pole (See page 72). The gain should be cut on the concave side in the plane of curvature.

Two 11/16" crossarm bolt holes should be drilled at right angles to the surface of the gain. One 10" from high top of pole and the other 24" below the top hole.

All poles should be gained and holes bored prior to treating. Poles ordered for bracket line construction should be slab gained and one crossarm bolt hole drilled, if future expansions can be foreseen.

Bark Removal and Defects. -

All outer bark must be completely removed. All poles should be free from serious defects such as decay, insect damage and splits and cracks.

Pole Dimension Tables. -

Use lengths 22' to 50', inclusive, for classes 3,4,5,& 6.

Southern Yellow Pine (Pressure Treated)
Minimum Pole Dimensions

Class	3	4	5	6	7
Top Circumference in inches	23	21	19	17	15
Length in feet	Circumference in inches 6 feet from butt				
22	29.0	26.5	24.5	23.0	21.0
25	30.0	28.0	26.0	24.0	22.0
30	32.5	30.0	28.0	26.0	24.0
35	35.0	32.0	30.0	27.5	25.5
40	37.0	34.0	31.5	29.0	27.0
45	38.5	36.0	33.0	30.5	28.5
50	40.0	37.5	34.5	32.0	29.5

Western Red Cedar
Minimum Pole Dimensions

Class	3	4	5	6	7
Top Circumference in inches	23	21	19	17	15
Length in Feet	Circumference in inches 6 feet from butt				
22	31.5	29.0	27.0	25.0	23.0
25	33.0	30.5	28.5	26.0	24.5
30	35.5	33.0	30.5	28.5	26.5
35	38.0	35.5	32.5	30.5	28.0
40	40.5	37.5	34.5	32.0	-
45	42.5	39.5	36.5	-	-
50	44.5	41.0	38.0	-	-

Lodgepole Pine (Pressure Treated)
Minimum Pole Dimensions

Class		3	4	5	6	7
Top Circumference in inches		23	21	19	17	15
Length in Feet		Circumference in inches 6 feet from butt				
22	22	29.0	26.5	24.5	23.0	21.0
	25	30.0	28.0	26.0	24.0	22.0
	30	32.5	30.0	28.0	26.0	24.0
	35	35.0	32.0	30.0	27.5	25.5
	40	37.0	34.0	31.5	29.0	27.0
	45	38.5	36.0	33.0	30.5	28.5
	50	40.0	37.5	34.5	32.0	29.5

PROTECTION DEVICES

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Arresters, Single Circuit, Outside Mounting, without fuses:		
#402S, used 2 type No. P-495 discharge blocks and 2 No. 1384 carbons.	For protection of line and life from lightning and power charges	Reliable Electric Co.
No. 1, uses 2 type No. 4500 discharge blocks and 2 type No. 2080 carbons.	For protection of line and life from lightning and power charges	Kellogg Switchboard and Supply Company
Arrester, Single Circuit, Outside Mounting, with fuses:		
#1000, uses 2 type P495 discharge blocks No. P-197 carbons and 2 No. 55 fuses.	For protection of line and life from lightning and power charges	Reliable Electric Co.
Type O-7, uses 2 type 4500 discharge blocks, 2 No. 2080 carbons and 2 type A7 fuses.	For protection of line and life from lightning and power charges	Kellogg Switchboard and Supply Company
Arrester, Five Line, Outside Mounting, without fuses:		
No. 222, uses 10 type P-495 discharge blocks and 10 No. P-663 carbons.	For protection of line and life from lightning and power charges	Reliable Electric Co.
No. 7, used 10 type 4500 discharge blocks and 10 No. 2080 carbons.	For protection of line and life from lightning and power charges	Reliable Electric Co.

PROTECTION DEVICES

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
*Fuses, No. 55, 7 ampere fiber with nut terminals, No. 2103-A7, 7 ampere wood with clip-in terminals.	For protection of line and life from lightning and power charges	Reliable Electric Co. Kellogg Switchboard and Supply Co.
Grounding Switch with Ball Gap Arrester:		
Type B-G for ground return lines, Type B-M for metallic lines.	For protection of line and life from lightning and power charges	Kellogg Switchboard and Supply Co. Graybay Electric Co.
Cook-Kellogg, Protector 99-A.		
**Insulating Transformers:		
Type 50A, Voltage Rating, 25 KV for one minute 121A, 25 KV for one minute.	For protection of line and life from lightning and power charges.	Western Electric Co.

*Fuses are for the protection of the wiring between the protector (discharge block) and the point of contact with power transmission lines. To avoid unnecessary blow-outs from lightning, a fuse rating of 5 or 7 ampere has been selected. In all instances matched fuses must be used to avoid circuit unbalance in metallic lines. (See arresters for fuse type requirements).

**This equipment falls into the classification of protection devices. (See discussion under Construction Standards). They are essentially repeating coils having characteristics similar to the standard coil. The coils are much larger and are so designed to offer excellent insulation between the various windings. It is general practice to mount these coils in the open on the pole.

PROTECTION DEVICES

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Arrester, Ball Gap:		
Type C-G, single gap for ground return lines, Cook-Kellogg.	For protection of line and life from lightning and power charges.	Kellogg Switchboard and Supply Company
Type C-M, double gap for metallic lines (Order complete with Federal Bushings for Knockouts).	For protection of line and life from lightning and power charges.	Kellogg Switchboard and Supply Company
Discharge Blocks, used with carbon block and clipped into assembly protector:		
P-495, Sawtooth Discharge Block, No. 4500 Gap discharger. (Do not include mounting or carbon blocks)	For protection of line and life from lightning and power charges	Reliable Electric Co. Kellogg Switchboard and Supply Company
Carbon Blocks, P-147, P-163, P-1384, No. 2080 (See protectors for carbon block requirements)	For protection of line and life from lightning and power charges	Reliable Electric Co. Kellogg Switchboard and Supply Company
Vacuum Arrester, G. & M.	For protection of line and life from lightning and power charges	Graybar Electric Co.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Protector, General Electric #99-A.	For use on lines exposed to power transmission lines	Graybar Electric Co.
*Rings, Cable, (Also see Hangers) 1-1/2" for 5/16" messenger strand.	For wire or cable messenger runs	Automatic Electric Co.
Rings, Drive, 5/8" to 1-1/2"	For wire or cable messenger runs	Graybar Electric Co.
Rod-Anchor Guy, 5/8" x 6' Kellogg Thimbleye #J-7416; Hubbard Guyeye #8416, Graybar Thimbleye #56, or equal.	For connecting guy to anchor	Hubbard and Company Graybar Electric Co.
Rod-Anchor Guy, hot galvanized, Kellogg Thimbleye #J-7418; Graybar Thimbleye #58, or equal, 5/8" x 8'.	For connecting guy to anchor	Kellogg Switchboard And Supply Co. Graybar Electric Co.
Rod-Anchor Guy, 3/4" x 6', hot galvanized, for attaching two guy strands to one anchor Kellogg Twineye #J-7526, Hubbard Tu-Guyeye #8526, Graybar Twineye #360 or equal	For connecting guy to anchor	Kellogg Switchboard And Supply Co. Graybar Electric Co.

*Cable rings are available in several additional sizes but for ordinary installations the above size will meet average conditions. Cable rings are also available in copper covered material but these should not be used with galvanized strand for reason of electrolytic corrosion.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Rods, ground:		
Type / Size		
#9435 Copper covered Steel Rod 5/8" x 5' or 6'	For connections to ground	Hubbard and Company
#9436		
#29435 Copper cover Steel sectional ground rod 5/8" x 5'	For connections to ground	Hubbard and Company
#9534 Sectional rod coupling 5/8" rod size	For connections to ground	Hubbard and Company
#29534 Driving stud	For use in driving extension rods	Hubbard and Company
#6592 Ground rod clamp,	For connections to ground	Hubbard and Company
*Saddles, Cable	For use with cable hangers	
Screws, lag, Fetter drive type, #9754½, 1/2 x 4 1/2 galv. iron lag screw.	Attachment of crossarm braces, storm guy straps, junction boxes, etc., to poles.	Hubbard and Company
Screws, wood, blued, round-head #8, 1 1/2" long.	Telephone and auxillary installations	
Screws, Fetter Drive		Graybar Electric Co.
Screws, Brass or galv. #10 2½" long.	Outside service wire installations	Graybar Electric Co.

*The use of cable saddles is not essential except where vibration conditions would cause chafing of the insulation on the drop wire.

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Screws, Angle 5/16"	For installing service wire on buildings	Graybar Electric Co.
Shields, Lead Expansion, #31	Used with wood or lag screws for masonry attachments	Hubbard and Company
Shields, guy, wood 1" x 4" x 6', District made, Steel, half round 7 feet with 2 bolts, 14 gauge.	For guy wire protection and prevention of injury	Hubbard and Company
Signal Set, loud sounding, for permanent installation 2500 ohm line relay, 6 volt Industrial horn, storage battery. Forest Service Specifications	For increasing volume of signal or telephone	Forest Service Laboratory
Signal Set, loud sounding portable, in carrying case, same as above except using dry cell batteries. Forest Service Specifications	For increasing volume of signal or telephone	Forest Service Laboratory
Sleeves, "Servisleeve", for 1/4" and 5/16" guy strands, hot galv. #7454.	For serving ends of guy strands	Hubbard and Company
Sleeves, splicing.	For splicing, topping, deadending and reducing wires	Graybar Electric Co. Automatic Electric Co. National Telephone Supply

SLEEVES, SPLICING TOOLS AND SLEEVES

Wire Size and Kind	Type of Tool	Splicing Sleeves	Offset Dead-End Sleeves	Reducing Sleeves to #14	Reducing Sleeves to #17	Reducing Sleeves to #12	Reducing Sleeves to #10	Repair Sleeves	Tap Sleeves
#12 AWG Copperweld	31-CJ	1-080C	91-080C	1-080x064C	1-080x045C	--	--	R1-080C	--
	31-DJ	1-080D	91-080D	1-080x064D	1-080x045D	--	--	R1-080D	--
#10 AWG Copperweld	31-CJ	1-102J	91-102J	1-102x064C	1-102x045C	--	--	R1-102J	--
	31-DJ	1-102J	91-102J	1-102x064D	1-102x045D	--	--	R1-102J	--
	51-PJ	1-102J	91-102J	--	--	--	--	R1-102J	--
#8 AWG Copperweld	51-PJ	1-128P	91-128P	1-128x064J	--	1-128x080J	1-128x102J	R1-128J	--
	31-E	--	--	1-128x064E	1-128x045E	1-128x080E	1-128x102E	--	--
	31-DJ	1-128J	91-128J	1-128x064J	--	1-128x080J	1-128x102J	R1-128J	--
	31-CJ	1-128J	91-128J	1-128x064J	--	1-128x080J	1-128x102J	R1-128J	--
#6 AWG Copperweld	51-PJ	1-162P	91-162P	1-162x064J	--	1-162x080J	1-162x102J	--	--
#10 B&S Hard Drawn Copper	31-CJ	1-102C	91-102C	1-102x064C	1-102x045C	1-102x080C	--	R1-102C	--
	31-DJ	1-102D	91-102D	1-102x064D	1-102x045D	1-102x080D	--	R1-102D	T1-102D
#8 B&S Hard Drawn Copper	31-CJ	1-128J	91-128J	1-128x064J	--	1-128x080J	1-128x102J	R1-128J	--
	31-DJ	1-128J	91-128J	1-128x064J	--	1-128x080J	1-128x102J	R1-128J	--
	51-PJ	1-128J	91-128J	1-128x064J	--	1-128x080J	1-128x102J	R1-128J	--
	31-E	1-128E	91-128E	1-128x064E	1-128x045E	1-128x080E	1-128x102E	R1-128E	--
#12 BWG Iron	31-CJ	5-109C	95-109C	2-109x064C	2-109x045C	4-109x080C	2-102C	R4-109C	--
	31-DJ	5-109D BB	95-109D BB	2-109x064D	2-109x045D	2-109x080D	2-109x102D	R2-109D	T2-109D
									T2-109x045D
#9 BWG Iron	31-CJ	2-148J	92-148J	2-148x064J	--	2-148x080J	2-148x102J	R2-148J	--
	31-DJ	2-148J	92-148J	2-148x064J	--	2-148x080J	2-148x102J	R2-148J	--
	51-PJ	2-148J	92-148J	2-148x064J	--	2-148x080J	2-148x102J	R2-148J	--
	31-GC	5-148G	95-148G	--	--	--	--	--	--
#14 B&S Copper .064	17-2	3-064B	--	--	--	--	--	--	--
#17 B&S Bronze .045	17-2	3-045B	--	--	--	--	--	--	T2-045B

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Staples, fence, galvanized 1" - 1-1/2"	For general use	Hardware Supply House
Staples, 2" long, square top, 1/2" spread at head and points, #9 gauge, regular barbed wire fence staple material. Forest Service Specifications.	For general use	Hardware Supply House
Staples, 4" wrought iron, Stanley #976 or equal,	For tree lines (thick bark tree line construction)	Hardware Supply House
Staples,3" galv., #8522 or equal.	For tree lines (thin bark tree line construction)	Hardware Supply House
Staples, #6, insulated	For fastening inside wire	Graybar Electric Co.
Staples, Moulding, Galv. #7522	For fastening moulding	Graybar Electric Co.
Steps, Pole, type #7125, 5/8" x 9" hot galv. steel	For Pole Stepping	Hubbard & Company
Steps, Pole, #6124, 5/8" x 9", hot galvanized steel, Locke Insulator Corp.	For Pole Stepping	Locke Insulator Corp. Hubbard and Company
Steps, Pole, ROB 576, 1-3/4 x 2-3/4" x 7" oak steps.	For bottom steps on stepped poles	Graybar Electric Co.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Strand, guy, (See "Wire-guy and messenger Strand")	For guys	Graybar Electric Co. Automatic Electric Co.
Straps, Storm Guy, #6001, 1/4" x 1-1/4" x 7" hot galvanized steel.	For pole guy attachments.	Hubbard & Company
Straps, pipe, hot galv., two-hole type.	For grounding wires to pipes	Hubbard & Company
Strap, Perforated, Steel, hot galvanized.	For reinforcing bracket on corner poles	Hubbard & Company
Solder, Rosin Core, Kellogg or Graybar	For use at corners in bracket line construction	Kellogg Switchboard and Supply Co. Graybar Electric Co.
Switchboards, (See Switchboards)		
Switch, Federal, Anti-capacity, DPDT, DPST, SPDT, SPST.	For temporary switching	Graybar Electric Co.
Tape, friction, 3/4" wide in 1/2 lb. rolls, tape, rubber, gum, splicing compound, in 8 oz. rolls. Victor's splicing tape or equal.	For insulating electrical joints	Graybar Electric Co.

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Telephone, wall, 5 bar magneto, 2500 ohm ringer, condenser in the receiving circuit, space for dry cells in box, #1417-S, Kellogg #5-4886, or equal	Telephone Instrument	Western Electric Co. Kellogg Switchboard And Supply Co.
Telephone, wall, short, 5 bar magneto, 2500 ohm ringer condenser in the receiving circuit, (no battery box, 1 needed), Kellogg 5880-M or equal.	Telephone Instrument	Kellogg Switchboard and Supply Co.
Telephone, desk, stand type with separate generator and bell box, 5 magneto, 2500 ohm ringer, condenser in the receiving circuit, no battery box. Desk Stand - Kellogg F-30; Western Electric #1020-AL, or equal. Desk set box - Kellogg F-237 Western Electric 300-M, or equal.	Telephone Instrument	Kellogg Switchboard and Supply Co. Western Electric Co.
Telephone, wall or desk-mount handset switchhook, separate generator and bell box, same as below except compact switch-hook, Western Electric G1-3 or Kellogg 9375. Used in place of desk type cradle. For handsets only, less cradle, specify Western Electric F1-AW-3, or Kellogg F-27-c, or equal	Telephone Instrument	Kellogg Switchboard and Supply Co. Western Electric Co.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Telephone, handset and cradle type with separate generator and bell box, 5 bar magneto, 2500 ohm ringer, condenser in the receiving circuit, long cord to desk set box, no battery box. Handset and cradle - Western Electric 250-AW-3, Kellogg 925-A or equal. Desk set box, Western Electric #300-N; Kellogg #F-2371, or equal or Kellogg handset and cradle with 930-CLR with #2562 box.	Telephone Instrument	Western Electric Co. Kellogg Switchboard and Supply Co.
Telephone, outdoor weather-proof, cast iron housing, light duty 5 bar magneto, 2500 ohm ringer, space for dry cells, condenser, receiving circuit, when specified - Kellogg #4883, Western Electric #13365 or equal.	Telephone Instrument	Western Electric Co. Kellogg Switchboard and Supply Co.
Terminals, Junction Terminal, outside, (Waterproof unprotected types, i.e., without lightning protection or fuses) Reliable RU cable terminal (Less Stub) - This terminal is illustrated in the methods section with ring and entrance construction date.	For terminating inside wires	Reliable Electric Co.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Terminals, Cook XB cable terminal (Less stub) - available in 6-11-16 and 26 pair.	For terminating outside wires	Kellogg Switchboard and Supply Co.
Terminals, Junction, Inside multiple pair type in cabinet, Cook WXB building terminal (Less Stub), available in 5-11-16-26 pair. Surface or flush mounted.	For terminating inside wires	Kellogg Switchboard and Supply Co.
Terminals, Junction, Inside single circuit connecting blocks: 2 point type with cover plate, Kellogg 25-A with #58887 cover.	For terminating inside wires	Kellogg Switchboard and Supply Co.
Tool Splicing, Type 31 CJ Type 31 DJ Type 31 PJ (See Sleeve and Tool Table for proper size, Page 253.)	For compressing Nico press sleeves.	National Telephone Supply Co.
Washers, #7802, round 1¼ OD x 14 GA - ½" hole for 3/8" carriage bolt, hot galvanized iron.	For use with #9634 crossarm brace bolt.	Hubbard and Company

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
Washers, Square, #7813 square, 2¼ x 2¼ x 3/16" with 11/16" hole for 5/8" bolt.	For use in attaching crossarms, stubbing, etc.	Hubbard and Company
Washers, top, #5664, Centering Washers.	For use with steel pins.	Hubbard and Company
Washers, bottom, #5684, Centering Washers.	For use with steel pins.	Hubbard and Company
Washers, curved, 2½" x 2½" x 3/16".	For guy construction to distribution strain	Hubbard and Company
Wire, #18, Bridle	For entrance construction	
Wire, emergency, single conductor, 10 strand, #29 AWG copper, waterproof. Latex Emergency Wire Specifications.	For emergency construction	Automatic Electric
Wire, emergency, two conductor, 10 strand, #29 AWG copper, waterproof. Latex Emergency Wire Specifications.	For emergency construction	Automatic Electric

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
*Wire, Drop, Gauge - #17 AWG:	For entrance construction	
**Wire, copper-covered.	For line wire	

*Resistance for 1000 ft., copper-covered 20 ohms, bronze 15 ohms.
Breaking load - single strand, copper-covered 220 lbs., bronze 170 lbs.
Breaking load - twisted or parallel pair, copper-covered 400 lbs., 340 lbs.

**Copper-covered steel wire is given two ratings by the manufacturer, 30% conductivity and 40% conductivity. This percentage figure represents the conductivity of copper-covered steel wire in its relation to pure copper wire. These relative values are determined by the amount of copper covering the wire. Federal specifications should be used for procurement purposes. The 40% conductivity wire should be used exclusively.

Copper-covered wire is not packaged in any specified length. The rolls are approximately one mile long. To determine the exact length of a roll, determine its weight and apply the weight per mile figure in the following table.

Wire, Line

The line wires listed below in the table of physical and electrical characteristics are standard sizes and types for Forest Service lines.

PHYSICAL AND ELECTRICAL CHARACTERISTICS OF LINE WIRE

Wire Characteristics	Wire Size: No. 9 BWG Galv. Iron EBB	No. 12 AWG, High Strength, 40% conductivity, Copper Covered Steel Wire	No. 10 AWG, High Strength, 40% conductivity, Copper Covered Steel Wire	No. 8 AWG, High Strength, 40% conductivity, Copper Covered Steel Wire	No. 6 AWG, High Strength, 40% conductivity, Copper Covered Steel Wire	No. 10 B&S HD Copper	No. 8 B&S HD Copper
Diameter in Inches	.148	.081	.102	.128	.162	.102	.128
Rated breaking load (lbs.)	785	785	1130	1660	2433	529	826
Weight per mile	314	96	152	242	385	166	264
Standard Pkg. length	1/4 mi.	Mill length coils Approximately 1 mile					1½ mi.
Resistance per 1000' 68°F	2.92	4.05	2.53	1.6	1.01	1.04	.65
Resistance for one loop mile (2 miles of wire)	30.9	42.8	26.7	16.9	10.7	11.0	6.9
Transmission Loss per loop mi. 1000 cycles	*	.25db	.21db	.15db	.11db	.07db	.07db	.05db

*Value varies with age and condition

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
*Underground wire and cable "12 gauge copper; 8 layer non-hygroscopic insulation; 5000 volt rating; without metallic armor. "Trenchlay" or equal.	Single conductor - for single ground return line entrances. Two conductor - for single metallic line entrance or for ground return lines enter same building.	Graybar Electric Co.
Telex - #17 gauge tinned copper duplex, rubber covered.		Graybar Electric Co.
Telex - Metallic armored - same as above		Graybar Electric Co.
**Guy and Messenger Strand 5/16" 7 strand Siemans-Martin grade or equal, rated min. breaking strength 5350 lbs. wire diameter 104, weight per 1000' - 205 lbs.		Graybar Electric Co.

*Multiple conductor, internal twisted pairs - for multiple metallic lines. (Use quaded cable, same external construction, for phantom circuit entrance where distance exceeds 200 ft.)

Above cable is seldom carried as a stock item by distributors but is made up on order. Use complete description of desired cable. No catalog numbers available.

**Since Forest Service pole systems are seldom required to support more than a small number of attached lines and other fixtures, guying requirements can be met by the use of a single size of strand. In some instances the 5/16" strand may be larger than necessary for the stresses applied but for sake of reducing the number of types of hardware other sizes are not standardized.

MATERIALS

NAME OF ARTICLE	PRINCIPAL USE	SUPPLIED BY
*Wire, U distribution,	This wire may be used underground for single circuits, without any additional protection or insulation. (Use only on single circuits)	Graybar Electric Co.
Tie wire and Reinforcements, for Tree Line:		Graybar Electric Co. Automatic Electric Co.
No. 9 E.B. -Galv. Iron Wire	Split insulator Attachment wire	
No. 10 A.W.G. - copper-covered hard-drawn	Split insulator Attachment wire	
No. 8 AWG copper-covered wire No. 6 AWG copper-covered wire	Reinforcements for copper-covered Grip-flex reinforcement 30" in length steel wire used in tree line construction.	
Grip-flex Reinforcement #12 AWG, copper-covered wire (Less Binding wire) #10 AWG, Copper-covered wire #8 AWG, copper-covered wire #6 AWG, copper-covered wire	Grade snubbers for copper-covered steel wire	Graybar Electric Co. Automatic Electric Co.

*Requirements can be met by the use of a single size of strand. In some instances the 5/16" strand may be larger than necessary for the stresses applied but for sake of reducing the number of types of hardware other sizes are not standardized.

For Tight Tie (For tieing line wires to insulators)

Type of Line Wire	Cat. No.** Tire Wire & Reinforcement	Reinforcing wire, size and length	Binding or tie wire* size & length	Approx. wt. per 100 complete ties
No. 12 AWG Copper-Cov. Steel	1012	10AWG x 10"	12 AWG x 24"	6 lbs.
No. 10AWG Copper-Cov. steel	910	9 AWG x 12"	12 AWG x 24"	7 lbs.
No. 8AWG Copper-Cov. steel	78	7 AWG x 15"	10 AWG x 24"	14 lbs.
No. 6AWG Copper-Cov. steel	56	5 AWG x 17"	9 AWG x 28"	25 lbs.
No. 10 AWG Solid Hard drawn copper	910	9 AWG x 12"	12 AWG x 24"	7 lbs.
No. 8 AWG Solid Hard drawn copper	78	7 AWG x 15"	10 AWG x 24"	14 lbs.
No. 9 EBB Galv. Iron		None	#12 Galv.Iron	Cut as needed

*Factory annealed copper-covered steel wire.

**Cat. No. includes both the reinforcing wire and the binding wire. (For maintenance purposes order the binding wire only, as the reinforcing wire is seldom damaged when line re-tying is required.) Supplied by Graybar Electric Co., and Automatic Electric Co.

191. General

Systematic and regular maintenance is essential to a consistently high service standard. Obviously if prescribed construction standards are effective there should be little need for maintenance instructions but for some time to come it will be necessary to work with installations of relatively low standards which were thought to be adequate at the time of construction. Effective maintenance requires careful planning and a full knowledge of construction standards. In the maintenance of telephone lines as with all structures it is important that defects be remedied promptly and regularly in order to avoid the pyramid of costs which always results from delay and makeshift.

192. Tree Lines

(a) Brush, limbs and leaning trees which may be grounding the line or which are likely to do so during the field season should be cut out. Brush must be disposed of in such a manner that it does not constitute a fire hazard. Inspect the line wire to see that it has not been damaged and that it returns to normal position when obstacles are removed.

(b) Clearance of line wire should be maintained at a minimum of four feet, and all brush, limbs, etc., should be trimmed out accordingly. Give full consideration to limbs, especially where they may be weighted down from snow and ice. Where such is possible a greater clearance should be provided both on the sides and overhead. Fast growing trees such as cottonwoods, alders and other rapid sprouting growth should be cut close to the ground during the time of year to discourage sprouting.

(c) Tie wires and insulators should be carefully checked and broken insulators replaced where needed. See that tie wires are in effective position and where the line is pulling against tie trees, select an alternate tree for a new tie or change the insulator and tie to the proper side.

(d) Line wire should be examined closely for loose or corroded connections or lengths where extreme stress has stretched the wire. Such defects should be cut out and compression type sleeve connections installed.

(e) Breaks should of course be repaired promptly and damaged wire cut out. Careful check of the vicinity should be made for conditions which may be likely to cause a repetition.

(f) Slack should be sufficient to allow the line to be pulled to the ground in any span and where necessary additional slack should be cut in. Enough slack should be allowed to compensate for tree or pole sway.

(g) Following is a suggested tool and material list for a two man crew:

Tools	Material
1 Saw, prunning	Line wire
1 light ladder, 16'	Tie wire
2 pliers - 8"	Staples
2 lineman's belts	Split tree insulators
2 lineman's Safety straps	Sleeves
2 Nicopress splicing tools	Bridging Connectors
1 Axe, double bit	
1 Cross cut saw, 1-man bow type	
1 hand axe	
1 rope, 3/8" or 1/2" x 50'	
2 grips	
1 Abrasive cloth	

193. Pole Lines

(a) Poles

Inspect each pole carefully for possible fungus attack and where pole is in questionable condition it should be replaced. Guys should be placed where uncompensated stresses are found to be developing.

(b) Guys should be tight and the wires in satisfactory condition. Check to see that guy shields are installed where required.

(c) Line wires should be properly and equally sagged. All defective splices should be cut out and replaced with compression type sleeves. See that clearance is in accord with standard requirements and check carefully at crossing installations for possible structural weakness.

(d) Ground installations should be inspected for tight connections and there should be ample assurance that the type of installation is proper for the particular location and that it is fully serving the purpose for which it was intended.

(e) Brackets which are loose or split should be replaced and bracket clips should all be in place.

(f) Crossarms should be tightly bolted to the pole and properly braced. All crossarm brackets should be checked to see that they are tight. Replace broken damaged or unserviceable crossarm pins.

(g) Insulators

Replace all broken or chipped insulators and be sure that all insulators are hand tight on the pins or brackets.

(h) Tools and Material

Following is a suggested list of tools and material for a two-man crew for pole line maintenance:

Tools

2 Pliers, 8"
2 Climbers, pole
2 Belts, lineman's
2 Tools, Nicopress, splicing
2 straps, safety
1 Axe, double bit
1 axe, hand
1 hammer
1 wrench, lineman's
1 bar, tamping
1 block & tackle, w/grips
1 saw, 1-man bow type
1 saw, pruning
1 cloth, abrasive
1 rope, 3/8" or 1/2" - 50'
1 shovel LHRP

Line wire
Tie wire
Sleeves, Compression type
Insulators
Brackets
Bracket clips
Nails - 30d & 60d
Crossarm pins
Bridging Connectors

194. Circuit Noise

Any electrical interference with the desired communication on a line is termed "noise". The four principal types of noise are:

(a) power hum

(b) cross talk from other circuits

(c) static from lightning and other electrical storms

(d) noise resulting from poor splices, intermittent contact with other objects, etc.

The degree to which noise is a problem depends upon its ratio to the desired signal as heard during a conversation. The addition of one unit of noise is equivalent to the loss of one unit of communication. A line is not considered serviceable where noise noticeably interferes with communication. Short lines, where communication signals are very strong, could of course have a reasonable amount of noise without seriously interfering with communication. Long lines, heavily loaded, cannot have an appreciable amount of noise and be serviceable.

Ground return lines are subject to all four interferences and even where the line is properly constructed interference

noise may exist. Where it does there are no simple ways to eliminate it. Metallic circuits properly designed, constructed, and maintained should be noise free.

The following is a list of the causes of noise on metallic circuits:

Leakage - Metallic lines should be well insulated from earth and other conductors. There is usually a potential or voltage between a well-insulated metallic system and ground. This voltage is stationary under normal conditions; however, if one wire of the lines becomes grounded, the voltage will cause a current to flow. This flow of current will pass through the attached instruments and cause a noise. Such unwanted grounding or leakage is quite easily determined by use of an ohmmeter or wheatstone bridge.

In simple circuits it is usually necessary to disconnect attachments suspected as sources of leakage and, in some instances, to open the line at one or more points and test each way, thus isolating the defective section. Pre-installed test stations as shown on page 165 facilitate such leakage tests and avoid line splicing.

The following are the most frequent sources of leakage:

Underground cables
Contact with guy wires
Breakdown in arresters
Breakdowns in switchboards and other attachments
Drop wire leads
Breakdown between winding in repeat coils
Abnormal insulator leakage due to accumulations of moss or other foreign matter

The degree of line insulation necessary to keep noise interference low is largely dependent upon the amount of voltage on the line.

Lines that are heavily exposed to power should be terminated with a repeat coil where the open wire lines join cables, or drop wire leading into switching stations and other such installation where leakage possibilities are most likely to occur. In general, there is little difficulty in keeping the open-wire systems relatively free from leakage or grounds. Cables, drop wires and installations of all sorts are constant sources of leakage. By use of the repeat coil, the voltage on the line has no opportunity of reaching ground through the station cables and attachments, because of the insulation provided by the repeat coil.

195. Longitudinal Unbalance in Line Conductors

Both line wires in a metallic circuit should have the same transmission resistance over any given section. If one wire has more resistance than the other wire, it becomes effectively longer and thus the transposition scheme is upset, causing noise. Phantom circuits are particularly susceptible to longitudinal unbalance.

To test for such unbalance, it is usually necessary to disconnect intermediate attachments and ground both line wires at one end. An ohmmeter or wheatstone bridge can then be used at the ungrounded end to measure the resistance of each line, with respect to ground, to determine any difference.

The most frequent causes of longitudinal unbalance are:

(a) Faulty splices and other line connections.

(b) Unbalanced series fuses.

(c) Wire gauge reduced by excessive elongation, due to ice or snow loading

(d) Mismatched line conductors - for any section of line, both line wires in that section should be identical as to gauge, material, and age.

196. Contact with Other Conductors

Contact between the metallic line and other insulated lines or conductors can cause serious noise; this results in a flow of current between the two, which sets up circulating current through the telephone system. It is pointed out that the foreign line in contact with the telephone line need not be a power circuit. In some instances even a short wire 4 or 5 feet long may cause serious noise.

Careful visual inspection is usually the only means of finding such troubles. Ohmmeters are often used to determine if there is a contact between a line and an adjacent telephone circuit. For safety, make sure that other conductors do not carry hazardous voltage prior to contacting them for test purposes.

The following are often causes of noise:

(a) Contact with other telephone lines. Except for some types of metallic phantoms, all telephone circuits should be well insulated from each other.

(b) Contacts with insulated section of guy wires.

(c) Stub lines (ground-return branch lines) feeding noise into an otherwise quiet circuit.

There have been numerous instances where ground-return branch lines connected to metallic systems through repeat coils have coupled noise into the metallic system. In such cases, listening tests should be made to determine if the ground-return line is quiet or noisy.

Where the noise is due to power circuits adjacent to the ground-return system, it will be necessary to metallicize one or more sections, depending upon the circumstances. To avoid unnecessary metallic construction, tests should be made to determine the extent of the exposure. Usually the line can be opened at successive intervals and listening tests will reveal the exposure zone.

197. Unbalance Due to Improper Transpositions

Where well-designed transposition plans are developed and properly installed, noise directly attributable to the transpositions, will seldom be encountered.

Most transposition troubles, which develop after the line is constructed, can be attributed to failure to reinstall the proper transposition when making repairs to a damaged line.

198. Cross-Talk on Metallic Systems

Cross-talk on metallic systems can usually be traced to such faults as:

(a) Leakage to ground

(b) Contact with other lines

(c) Coupling due to split pairs in cables and lines

(d) Leakage in entrance construction, local distribution leads, and switchboards

199. Noise on Ground-return lines

Since ground-return lines are not satisfactory when constructed near power systems, or parallel to other ground-return lines, the noise caused by such parallels will not be considered. Earth currents resulting from heavy power grounding, especially as in the case of cooperative grounded power lines, can cause serious noise to ground-return telephone lines that are not constructed parallel to the power line. The location of telephone grounds should receive special consideration to avoid

installing them in areas where heavy earth currents are caused by power grounding. In some areas where soil conditions are generally poor, concentrated conduction paths may carry power-line earth currents through areas served by ground-line telephone systems which are several miles from the power system. Where this is a problem, a short section of metallic line and, in some instances, a repeat coil may serve to prevent such earth currents from flowing through the telephone system. These are special problems and it is not practicable to attempt to show details which cover all cases.

Static caused by electrical storms is usually severe on ground-return lines. Such static is most severe on lines constructed along high, exposed ridges. There is no simple solution to this problem.

200. Repair Sleeves for Line Wire

Repair sleeves are used to restore the conductivity of a line by replacing high resistance and defective splices without changing the sag of the line. To install a repair sleeve, first hold the line with wire grips and tackle; then cut out the defective splice. Clean wire ends with abrasive paper or #00 emery cloth. Slip sleeve on the wire and compress in the usual manner. Do not clean more of the wire than will be inserted in the sleeve.

REPAIR SLEEVE

201. Telephone Instrument Maintenance

Many of the Regions have, in recent years, established central repair shops for the repair and rebuilding of telephone and associated instruments. The repair plan varies but little between the Regions. Some Regions completely rebuild an instrument when it is sent in for repairs while another finds the trouble and makes the necessary repairs and adjustments. However, all parts are usually tested and any indicating weaknesses are replaced. The experience of these Regions having central shops has been so favorable that the establishment of such a shop in each Region appears justified unless cooperative arrangements can be made with Regions so equipped.

The advantages of the central shop are many, but most important is the reduced numbers of instrument failures due largely to specific non-tampering instructions issued to fieldmen and to the skill with which instruments are repaired or rebuilt.

In view of the above no attempt is being made to write into this handbook a set of general instructions on telephone instrument repair. However, there follows a list of troubles and causes which may be consulted by non-technical fieldmen to determine what is wrong with their instrument.

(a) A telephone instrument is reliable. It has been constructed under high standards, is well engineered and is capable of giving good service over a large number of years if left alone.

(b) Most trouble in voice transmission over a telephone system occurs outside of the instrument usually from the terminal pole through the arresters to the instrument including the ground. Check all of this first before looking at the telephone instrument. Don't use a screw driver for any purpose other than to open the instrument door and to disconnect the line and ground wires or the receiver or transmitter cords. A telephone instrument usually gets out of adjustment, by an inexperienced person trying to improve the quality of voice or ringing circuits by use of a pair of pliers or screwdriver on parts which were working efficiently. For example the telephone ringer is weak and Mr. Inexperience starts in with his

pliers and screwdriver to adjust it to make it ring louder. He loosens the locking screws and moves the adjusting screws and after so long a time the bells won't ring at all and the instrument is reported as in need of repairs; later it is discovered that the ground connection was poor and was the cause of the weak ringing.

(c) Your telephone bell rings faintly or not at all when others call:

(1) Defective ringer - either open or out of adjustment.

(2) Broken wire or loose connection in the telephone set.

(3) Short circuit in your telephone or some other telephone on the line.

(4) Receiver off the hook at some telephone where there is no condenser on the receiving circuit.

(5) A low resistance ringer connected somewhere on the line.

(6) Open fuse at the arrester on the outside of the building.

(7) Short circuited line.

(8) Broken line wire or service wire.

(9) Line wire grounded by touching trees, brush or ground, if grounded circuit.

(10) Over loaded line - too many telephone instruments on the line.

(d) Bell rings frequently without apparent cause:

(1) Line crossed with other telephone line.

(e) All bells at a switching station ring when only one line is called:

(1) Wires crossed with another telephone line.

(2) Poor ground connections.

(3) Too high resistance of service wires.

(f) You can not ring bells of other telephones:

(1) Defective ringer at telephone being called - either open or out of adjustment.

(2) Defective generator - either at your own telephone or at the telephone called.

(3) Broken wire or loose connection in telephone set.

(4) Open fuse.

(5) Short circuited line, if metallic circuit.

(6) Line wire grounded by touching trees, brush or ground, if grounded circuit.

(7) Low resistance ringer connected somewhere on the line.

(8) Broken line wire or service wire.

(9) Poor ground connection.

(10) Over loaded line - too many telephone instruments on the line.

(g) Others can not hear you talk:

(1) Packed transmitter.

(2) Loose or defective connections to transmitter.

(3) Poor connections on receiver circuit of telephone being called.

(4) Open induction coil on either telephone.

(5) Hook switch out of adjustment at either telephone.

(6) Defective battery at either telephone.

(h). You can not hear others talk:

(1) Defective or dirty receiver.

(2) Poor connections on receiver circuit.

(3) Hook switch out of adjustment.

(4) Open induction coil.

(5) Open condenser on receiver circuit.

(6) Defective transmitting circuit on other telephone.

(i) Your conversation is interrupted so that at times you only hear parts of words and sentences:

(1) Loose connections somewhere on the line.

(2) Poor ground wire, if grounded circuit.

(3) Line wires short circuited, if metallic circuit.

(4) Line wire grounded by touching trees, brush, or ground, if grounded circuit.

(5) Line crossed with other telephone line.

(6) Defective receiving circuit.

(j) The telephones at terminals of the line have difficulty in ringing or hearing each other:

(1) Over loaded line - too many telephones on the line.

(2) Poor ground connections.

(3) Defective line connections.

(4) Line wire grounded by touching trees, brush or ground, if grounded circuit.

(5) Line wires short circuited, if metallic circuit.

(6) Line crossed with other telephone line.

CARE OF SPECIAL EQUIPMENT

202. Climbers, Lineman's

In order to provide for maximum effectiveness and safety, the leg irons should be best to conform to the wearer's leg.

Each employee shall assume the responsibility of determining that his climbers are in good condition at all times and an inspection should be made at least once each week.

The important conditions to look for when inspecting climbers are as follows:

(a) Fractured gaff or start of a fracture
(b) Loose gaff
(c) Length of gaff less than 1 1/8 inches measured along the inner surface
(d) Broken or loose strap loops
(e) Fractured leg iron or start of fracture
(f) Thickness of stirrup worn to 1/8 inch or less
(g) Dull gaff
(h) Improperly shaped gaff
(i) Difference of more than 1/8 inch in the lengths of the gaffs of a pair of climbers

If any of these conditions exist or if the condition of the climbers is such as to cause doubt as to their safety, an exchange for a pair in good condition should be made at once.

203. Sharpening Gaffs

The gaffs of lineman's climbers shall be kept sharp at all times. When sharpening a gaff, care should be taken to maintain the original shape of the gaff as nearly as practicable.

The minimum deminsions to which climber gaffs shall be sharpened are given in the following illustrations. The use of a gaff gauge is the most convenient means of checking the various measurements but if such a gauge is not available. a steel rule may be used for the purpose. (See p. 312.)

204. Precautions

The following precautions should be observed when storing, transporting and using linemen's climbers.

(a) In general, climbers should not be placed in the same container with body belts and safety straps. However should this be necessary, care should be taken to avoid any possibility of the gaffs cutting or puncturing the belts or straps.

(b) Use climbers of the correct size.

(c) Never wear climbers on work where they are not required as for example, when working on the ground, on a ladder, on a stepped pole where the work can be performed safely from the steps, or while traveling in any type of conveyance. Climbers should not be worn when walking in deep snow, over rough terrain, crossing fences or ditches, climbing or ascending embankments, climbing trees or under any other such conditions which might cause the employee to gaff himself or a fellow worker.

(d) When climbing past another employee who has his safety strap in place around the pole, special care should be taken to avoid dragging the gaffs over the other employee's strap and cutting it.

(e) Do not use the gaff as a pry.

(f) Avoid jabbing the gaff into a crack or knot.

205. Body Belt and Safety Strap

(a) Inspection of body belts, and safety straps should cover the following points:

(1) Broken steel reinforcing plates holding Dee rings.
(2) Leather of loop over reinforcing plates worn or crushed by the Dee ring at the edges sufficiently to affect its strength or cause the leather to tear.
(3) Loose or broken rivets. (particularly those in the loops holding the Dee rings)
(4) Broken or rotted threads in the stitching of loops holding Dee rings.

(5) Cracks, cuts, etc., that would tend to cause the leather to tear or be likely to affect the strength of the belt.
(6) Leather hard and dry.
(7) Broken plier holder
(8) Broken or defective buckle.
(9) Burnt leather.

(b) Cleaning and Dressing

Body belts, pads and safety straps should be cleaned and dressed at intervals of not more than three months. These intervals should be shortened when the belt pads and strap have been subjected to rain, perspiration or paint. When belt and strap have been used in connection with painting of poles, any paint should be removed with a dry cloth as the ingredients of the paint if allowed to dry in the leather, may have an injurious effect.

The results of tests indicate that creosote is not injurious to leather but it should be removed from the leather as soon as practicable in order to prevent clothing stains.

The following method has been found satisfactory for cleaning and dressing body belts, pads and safety straps.

(1) Wipe off all surface dirt with sponge dampened (not wet) with water. Never use gasoline which will cause a dry condition of the leather.

(2) Rinse sponge in clean water and squeeze nearly dry, then with the aid of a neutral soap work up a thick lather.

(3) Thoroughly wash the entire length of the leather to remove imbedded dirt and perspiration and wipe with cloth to remove excessive moisture.

(4) Proceed as in (2) using a good grade of saddle soap.

(5) Work lather well into all parts of the belt or strap and place article in shade to dry.

(6) When lather has practically dried rub vigorously with a dry cloth.

In general, while the saddle soap treatment will keep the leather soft and pliable for a reasonable length of time, oiling is ordinarily required about every six months for leather either in use or in storage.

(c) The following method of oiling for restoration of leather to the desired condition has been found satisfactory:

(1) Clean leather with a neutral soap. (Oil applied to dry or dirty leather has a harmful effect on the fibers.)

(2) While the leather is still damp use on each strap, pad or belt about 1/4 ounce (2 teaspoonfuls) of Neatsfoot or other animal or vegetable oil and supply gradually working it into the leather with the hands. A light even distribution of the oil should be sought. Do not use mineral oils or greases such as vaseline or machine oil. Leather should never look or feel greasy as this indicates that too much oil is being used. Leather with too much oil will stretch and is likely to pick up injurious sand or grit.

(3) After oiling the leather should be allowed to dry slowly in a dry, shady place for about 24 hours then rub vigorously with a soft cloth to remove excess oil.

206. Maintenance

Tool maintenance consists of cleaning, sharpening, removal of burrs, tightening, lubricating, rust prevention and replacement of parts.

(a) Cleaning

Remove dirt, paraffin, rust and other foreign matter by methods not injurious to the tools.

(1) Removing dirt: The size of a tool and its material determines the method of dirt removal. After cleaning the tool should be treated to prevent deterioration.

(2) Removing paraffin: Shave off as much of the paraffin as possible with a shave hook or clipping knife and remove the remainder with carbon tetrachloride or equivalent.

(3) Removing rust: The preferable method is to use steel wool, emery cloth or a wire brush. Kerosene is an effective rust softener but leaves a greasy film which must be removed if the tool is to be painted.

(b) Sharpening

Sharpening consists essentially of removing sufficient metal from the proper portion of the tool, to produce an edge or point of desired sharpness. Never remove more metal than is necessary.

Tools are tempered and too much heat will draw carbon from the steel and ruins the tool.

Maintain original bevel in all cases.

Sharpening methods are:

(1) Emory wheels - artificial stones operated at high speed for fast cutting. Always wear goggles when using an emory wheel. Avoid burning tool edges by cooling the blade frequently with water.

(2) Grindstones - Natural stones operated at slow speeds for sharpening highly tempered tools.

(3) Oilstones - both natural and artificial stones of size and fixture which adapts them to sharpening small highly tempered tools. Straight live strokes should be used to insure true edges.

(c) Removing Burrs

Use a file or emery wheel for removing mushroom portions. When mushrooming is excessive use a cold chisel or hacksaw to remove major portion of burr before shaping with emery or file.

(d) Tightening

(1) Periodically check rivets, bolts or screws which secure stationary members of tools to see that they are properly set up and serve the purpose for which intended.

(2) Tighten loose rivets by upsetting or riveting over the end of the rivet shank. This is accomplished by backing up the bend of the rivet with the face of a large hammer or other solid metal and striking the end of the rivet with a hammer.

(3) Use a wrench or screwdriver to tighten bolts or screws.

(e) Lubrication

(1) Before lubricating tools check to see that joints, bearings, sliding parts, etc., are free from grit or foreign matter which would interfere with the operation of the tool. If necessary, wash the tool in kerosene to remove foreign matter.

(2) If corrosion or foreign matter causes binding of joints as with pliers and the binding cannot be overcome by applying a light grade oil, immerse the tool for 12 hours or more in a solution which will penetrate and soften the foreign matter. Since such binding is primarily caused by rust, kerosene should be used for this purpose.

(3) Use oils and greases which will provide the proper lubrication without gummying or interfering with the operation of the tool.

(f) Rust Prevention

(1) Tools such as pliers, screwdrivers, etc., which are not rusted and which will not be painted shall periodically be given coats of rust preventive consisting of equal parts of linseed oil and turpentine. The interval between applications of the solution of course depends on whether the tool is in use or in storage and upon the local conditions which may promote or inhibit rust.

(2) Tools, on which only a small amount of rust appears shall have the rust removed with emery paper. When the rust is extensive, soaking first in kerosene will prove helpful. After rust is removed wipe tools clean and apply rust preventive.

207. Storage and Preservation

Proper care in storage is essential if maximum values are to be gained from tool investments. If a tool is worth storing it is worth the time and effort necessary to preserve the tool while in storage.

208. General Precautions

(a) Clean the tool.

(b) Lubricate or paint to preserve.

(c) Keep all tools arranged in an orderly manner on trucks, in kits, or in storerooms. When a special compartment or storage space is provided fcr a tool, keep it in that space when not in use.

(d) Heavy tools - do not store heavy tools in the same compartment with painted tools or with any other tools which might be injured by contact.

(e) Leather goods - See page 280 for principles and methods of care and preservation of leather.

(f) Rubber goods - Light, heat, pressure, and oil tend to deteriorate rubber and storage should be planned accordingly.

(g) Fiber goods

(1) When wet - dry by ventilation in order to avoid mildew or rot.

(2) Avoid high temperatures.

(3) Do not store with pointed or sharp tools.

(h) Wooden goods - Keep cool, dry, and well ventilated to prevent warping and twisting.

(i) Metal goods - Avoid rust, keep well lubricated.

(j) Tools Containing Batteries - Remove batteries.

(k) Sharp Tools - Store so as to avoid damage to cutting edges and store in such a way that other tools will not be damaged and injuries to personnel avoided.

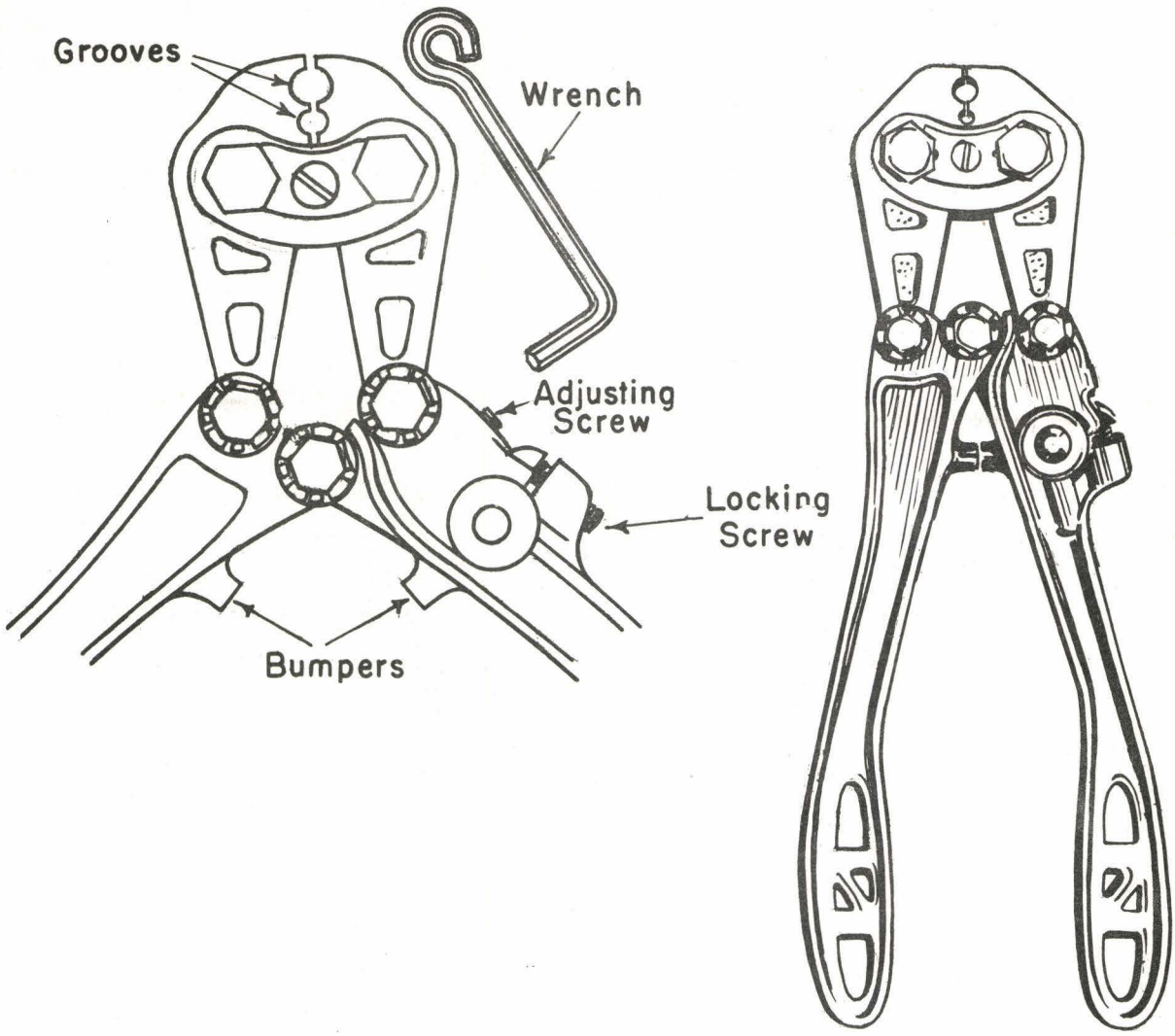
209. Adjustment of Compression Tools

To make a satisfactory splice, it is important that the amount of sleeve pressure be kept constant. The diameter of the compressions should be checked occasionally, especially after cleaning and oiling tool and before use after the tool has been stored for long periods. A gauge is provided for this purpose. It should be kept with the tools. (See page 133)

To adjust the tool, open the handles, use the small hexagon wrench provided for this purpose to loosen the locking screw (use no other) about two turns. Then turn, clockwise, the adjustment screw only a fraction of a turn. Then compress a sleeve and try the gauge on the compression. Continue to turn the adjustment screw a small amount at a time until pressed sleeve passes easily into the gauge. When the correct setting is obtained, turn up the locking screw hard so that tool will hold its adjustment.

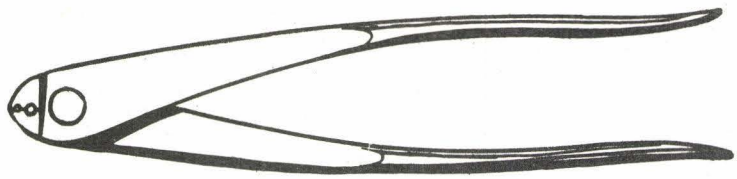
As the tools wear, they should be re-adjusted to meet the gauge requirement.

Where tools are in daily use, it is suggested they receive a monthly inspection. In addition to checking and adjusting where necessary, they should be cleaned and oiled. An empty tool should work freely with a slight spring at the final closing. If the tool binds, it can be eased by slightly loosening the particular hexagonal head bolt which is causing the binding. Lock the bolts after such adjustment by bending up one of the ears of the lock washer.



Remember, when holding the tool as shown above, the two bolts on the right-hand side of the tool have left-hand threads, whereas the other three bolts have right-hand threads.

Another type tool, with fixed grooves, is shown below. This tool is for use with 3-064B and 3-045B sleeves.



NICOPRESS TOOL
(Solid grooves)

Telephones and Associated Equipment Manufacturers and their addresses

Kellogg Switchboard and Supply Co.
6650 S. Cicero Avenue
Chicago, Illinois (General Telephone Supply House)

Graybar Electric Company
(Principal cities) (General Telephone Supply House)

American Automatic Electric Sales Co.
1033 West Van Buren St.
Chicago, Illinois (General Telephone Supply House)

James R. Kearny Corp.,
St. Louis, Missouri (Bridging Connectors - Kearny sleeves and associated equipment)

National Telephone Supply Co.
Cleveland, Ohio (Nico-press sleeves)

Copperweld Steel Company
Glass Port, Pa. (Copperweld wire)

A. B.Chance Co.
Centralia, Mo. (General telephone line hardware and parts)

Cooke Electric Co. (Manufacturers of associated
Chicago, Illinois telephone equipment)

Hubbard and Co.
6305 Butler St. (General Telephone Line Hard-
Pittsburgh, Pa. ware and parts)

Joslyn Mfg. & Supply Co.
20 N. Wacker Drive
Chicago, Illinois (Associated Telephone Equipment)

Reliable Electric Co.
3145 Carroll Ave.
Chicago, Illinois (Manufacturers of Associated Telephone equipment)

Knox Porcelain Corp.
100-200 Mynderse Ave.
Knoxville, Tennessee (Tree Insulators)

Owens - Illinois Glass Co.
Ohio Bldg.
Toledo, Ohio (Hemingray)

Armstrong Cork Co.
Lancaster, Pa. (Whithall-Tatum)

M. Klein & Sons
3210 Belmont Ave.
Chicago 18, Illinois (Telephone Lineman's tools manufacturer)

The R. Thomas & Sons Co.
Lisbon, Ohio (Tree Insulators)

Locke Insulator Corp.
Baltimore, Maryland (Pole steps, Porcelain Insulators)

Testing Equipment

Stewart Bros. Inc.
5303 West Harrison St.
Chicago, Illinois (Lineman's Testing Set)

American Automatic Electric
Sales Co.
1033 West Van Buren St.
Chicago, Illinois (West Test Set)

Linn O. Morrow
Schaff Building
Philadelphia, Pa. (Vibro Ground Test Set Ground Tester)

James G. Biddle Co.
1211-13 Arch St.
Philadelphia, Pa. (Megger Ground Testing)

Kellogg Switchboard and Supply Co.
6650 S. Cicero Avenue
Chicago, Illinois (Battery Tester, Sterling Pocket, Ammeter)

TOOLS

Augers

Augers, 6" to 10" - chance telescopic trip auger or equal.
Auger, bit, wood auger 11/16" x 18", S2527, Automatic Electric, #101 Graybar.
Auger, bit, wood auger 1/2" x 18", S2521, Automatic Electric, #101 Graybar.
Auger, bit, wood auger 3/4" x 18", S2529, Automatic Electric, #101 Graybar.

Axes

Axe, double bit, Plumb or equal.
Axe, single bit, Plumb or equal
Axe, lineman's belt, Plumb or equal.

Bags

Bag, tool, canvas, Graybar

Bars

Bar, tamping, 7' Oshkosh #1054 or equal.
Bar, digging, 1-1/8" x 8', Oshkosh #1064 or equal.
Bar, digging, made locally with 6½' black iron pipe with 15" of 1" steel welded on one end.

Battery Tester

Battery, Tester, Sterling Pocket Ammeter, Kellogg.

Belts

Belt, Lineman's body, width 3½", Kleins #5204 or equal.

Bits

Bits, wood auger 11/16" x 18", S2527, Automatic Electric.
Bits, wood auger 1/2" x 18", S2521, Automatic Electric.
Bits, wood auger 3/4" x 18", S2529, Automatic Electric.

Blocks, tackle

Block, tackle, light type, 3/8" rope, Klein's self-locking #1802-30 or equal.
Block, tackle, heavy type, 1/2" rope, Klein's #1802-40 or equal.
Block, tackle, caps tan pulley, 1/2" rope, Chance #2-2000 lb. or #22-3000 lb.

Blow Torches

Blow Torch, 1 qt. gasoline, Kellogg.

Braces, Carpenter

Brace, Carpenter, rachet, #S-3076, Automatic Electric.
Brace, Carpenter, corner, #S-3085, Automatic Electric.

Braid, Stripper, Kellogg, Graybar

Climbers, Lineman's

Climbers, lineman's pole, Klein's #1903 or #1939 or equal. Order by lengths.
Climber, lineman's tree, Klein's, #1907 or equal. Order by lengths.
Car, Cable - PU 37, Graybar Electric Co.

Deadman

Deadman 6' with two spikes, Oshkosh #842 or equal (often referred to as Tenny or support, Automatic Electric Co.)

Diggers, Posthole

Diggers, posthole, #501, Hubbard and Company.

Digging Bars

See Bars, Digging.

Drill, Star or 4 Point

Drill, Star or 4 Point, Masonry, Graybar Co.

Extension Ladders

Extension ladders, Graybar Co.

E-Z Wire Strippers

See Strippers, E-Z Wire.

Files

File, flat 8", Hardware.

Gloves

Gloves, tool, #100, Graybar
Gloves, protector, #118-C & 120-C, Graybar.
Gloves, rubber, Pouch, 5120, Graybar

Grips

Grip, wire, for No. 6 AWG and smaller, bare wire, Kleins "Chicago" No. 1613-30 or equal.
Grip, wire, for 1/2" and smaller guy strand. Kleins "Chicago" No. 1628-5 or equal.
Grip, flexible, Cable pulling, for pulling aerial or UG cable, Automatic Electric Company.

Guards

Guard, pike pole, No. 10 Oskosh, Graybar.

Ground Tester

Ground Tester, Vibro Ground Test Set, Linn O. Morrow

Ground Tester, Megger Ground Testing Set, James G. Biddle Company

Hacksaws

Hacksaw, Graybar Company.

Hooks

Hook, brush, Graybar
Hook, cant, Graybar
Hook, Carrying (lug), Graybar.

Hammers

Hammer, lineman's, Graybar
Hammer, claw, Graybar
Hammer, tack, Graybar.

Iron

Iron, soldering, Kellogg

Ladders

Ladder, extension, Graybar
Ladder, step, Graybar.
Lineman's Testing Set, Stewart Bros. Inc.
Lineman's Testing Set, West, Automatic Electric.

Pliers

Pliers, 8" sidecutting, Kleins #212-8, Graybar
Pliers, diagonal, Kleins, Graybar.
Pliers, long-nose, Kleins, Graybar.

Poles, pike

Pole, pike, 2½" x 10', A. T. & T. pattern, Oshkosh #817 or equal.

Pump, Water

Pump, Power Driven
Pump, Hand Power

Reels

Reel, folding take-up, Kellogg #10-501-897, Graybar #897, Joslyn #10-501, or equal.
Reel, payout, Oshkosh, Kellogg #10-510-902, or equal.
Reel, line wire, Forest Service Specifications.
Reel, emergency wire Forest Service specifications.
Reel, drumtype, payout, Graybar.

Rope

Rope, 7/8", high climbers, safety, Manila with flexible steel center.
Rope 1/2" Manila
Rope 3/8" Manila

Saws

Saw, hand, cross cut, 2-man
Saw, pruning, long handled, Franco Saw Works, Bartlett #44, Klein #3628 w/blade, Seymour-Smith #10, or equal.
Saw, hand pruning, Bushman, Kellogg or equal.
Saw, cross-cut, bow type.

Shovels

Shovel, telegraph, straight, #686-8', Graybar
Shovel, round point, long handled, 1090R, Graybar.

Spoons

Spoon, posthole, 8 ft. handle, Graybar #1024, Kellogg #10-051-1024 or equal.

Straps, Lineman's

Strap, lineman's safety - 1 3/4" x 5' 8", Klein-Kord, #5233 or equal.
Strap, lineman's safety - 2" x 5' 8" Kleins #5253 or equal.
Straps, and pads, lineman's climber, Kleins #5301-2 or equal.
Strap, lineman's, w/swivel hook, Howes Wire Tool #1702.

Strippers

Stripper, E-Z, wire, Graybar.
Stripper, Braid, Kellogg

Tester, Battery

Tester, Battery, Sterling Pocket Ammeter, Kellogg

Tester

Tester, ground Vibro ground testing set
Tester, set, Linn O. Morrow
Tester, Ground, Megger, Groung Testing Set, James G. Biddle Co.
Tester, Lineman's Testing Set, Stewart Bros. Inc.
Tester, West Test Set for Lineman, Automatic Electric

Tools

Tool, bag, Graybar
Tool, splicing, type 31 CJ, Nicopress, National Telephone Supply Co.
Tool, splicing, type 31DJ, Nicopress, National Telephone Supply Co.
Tool, splicing, type 31PJ, Nicopress, National Telephone Supply Co.

Tool Requirement

It is best for all workers on any job to be equipped with proper tools in sufficient number to do things efficiently. There follows tool requirement lists for specific jobs:

Tools Required for Attaching Crossarms

1	Bit, 11/16"
1	Bit, 3/8"
1	Brace, carpenter's, 10" sweep
1	Hammer, linesman, double-faced
1	Line, hand, 3/8" manila rope
1	Pliers, side-cutting, 8"
1	Rope, 3/8", manila, 18' long, with eye in one end.
1	Sheave, steel, 4"
1	Square, carpenter's
2	Wrenches, linesman

Tools required for stringing wire:

1 or 2	Hand-barrow type reels, adjustable combination pay-out and take-up type
2 or more	3/8", 40' hand lines
2 pair	8" side-cutting pliers
1/8 mi.	1/2" rope, running line, where wire is to be pulled over crossarms.

Tools Required for 8-Man Crew for Sagging and Tying in Wire

8	Grips, wire, Chicago, for bare wire No. 6 and smaller; Klein No. 1613-30.
8 sets	Self-locking blocks, Klein No. H-1802-30, with 25', 4-strand, 3/8" manila rope complete with grips.
2	3" steel, single-sheave blocks
1	4" steel, single-sheave block
1 pr.	4" steel double blocks, with 50', 1/2" manila rope
8 pr.	8", side-cutting pliers
2	Wire splicing tools
2	Sag gauge targets
2	40' hand lines
6	Tool belts and safety straps
6 pr.	Pole climbers
1	Thermometer
1 pkg.	Abrasive paper, or several sheets emery 00 cloth.

Torch, Blow

Torch, Blow, Graybar

Trimmer, Tree

Trimmer Tree, Graybar

Wrenches

Wrench, lineman's, Automatic Electric Co.
Wrench, lineman's, Kleins #3146
Wrench, socket #102, Graybar.

EASEMENT FOR TELEPHONE LINE ACROSS PRIVATE PROPERTY

State of_____
County of_____

This indenture made the____day of_____, 194___, between_____of the County of_____, State of_____, hereinafter called "Grantor", and the United States of America, hereinafter called "Grantee", WITNESSETH:

That for and in consideration of One Dollar ($1.00), the receipt and sufficiency of which is hereby acknowledged, Grantor hereby grants, bargains, sells, and warrants to Grantee forever a right-of-way and easement ten (10) feet in width with the right and authority to construct and operate a telephone line on and over the following described tract of land lying and being in_____County,_____ to-wit:

(Description of land)

Grantee shall have the authority to locate said telephone line as will be most convenient and economical, and may from time to time relocate said line if such relocation will result in a more economical operation of said line by Grantee; together with the right at any and all times of going on and over said tract of land above described to patrol said line and repair and maintain the same.

The herein described right-of-way and easement is granted and conveyed upon the condition that should said right-of-way or easement be abandoned by Grantee, as evidenced by the discontinuance of its use for a period of 90 calendar days, such right-of-way or easement shall thereupon terminate and revert to Grantor, his heirs and assigns, provided, however, that Grantee shall have the right to come upon said premises and remove any and all equipment, poles, and wire placed thereupon by Grantee, within a reasonable time after the termination of this right-of-way and easement.

IN WITNESS WHEREOF, Grantor has hereunto set his hand and seal the date first above written.

Witnesses:

_____ _____(Seal)

_____ _____(Seal)

Note: Use form of acknowledgement in common usage for the particular area concerned.

EASEMENT FOR TELEPHONE LINE
ACROSS RAILROAD RIGHT-OF-WAY

This agreement made this the____day of_____, 19__, between_____Company, a corporation, hereinafter designated as "Railroad" and the United States of America, hereinafter designated as the "Government".

Witnesseth:

1. For and in consideration of_____Dollars, receipt of which is hereby acknowledged, and in further consideration of the performance by the Government of the covenants hereinafter contained, the Railroad hereby grants to the Government and its assigns, subject to the terms and conditions hereinafter set forth, the right to construct, maintain and operate a telephone line of wires and cables, and supports and appliances in connection therewith, across the right-of-way of the Railroad, under the wires or under the tracks along said right-of-way at

in the County of_____, State of_____.

2. The said telephone line shall be constructed, maintained, operated, and removed by the Government at its expense and under the supervision and direction of the Chief Engineer of the Railroad.

3. The Government shall construct, maintain, operate, and remove the said telephone line in such manner as will not hinder or delay the passage of engines or trains over the property of the Railroad.

4. The Government shall, under the supervision and direction of the Chief Engineer of the Railroad, make all repairs to the tracks and other property of the Railroad necessitated by the Government's construction, maintenance, operation, and removal of the said telephone line.

5. If the Government violates any of the terms of this agreement and if steps are not taken to discontinue such violation before the expiration of ten days' written notice to the Government from the Railroad so to do, the Railroad may terminate this agreement after such ten days have elapsed by giving to the Government_____days' written notice of termination.

6. If the Railroad shall at any time desire the land occupied by the said telephone line and the necessary supports and appliances in connection therewith for any purpose with which the maintenance of said telephone line interferes, the Railroad shall have the right to terminate this agreement by giving the Government_____ days' notice in writing. In such event, however, the Government may, at its option, relocate and maintain said telephone line, and the necessary supports and appliances therefor, at another location on the Railroad's right-of-way to be designated by the Railroad. If the Government relocates said telephone line, this agreement shall continue in full force and effect. If the Government fails to exercise this option, it shall remove said line as provided in section 8 hereof.

7. Notice in writing to be given to the Government under the provisions of this agreement shall be addressed to the Forest Supervisor,

_____.
(Address)

8. Upon termination of this agreement, the Government shall at its expense promptly remove the said telephone line and supports and appliances in connection therewith for the property of the Railroad.

9. Subject to any right to cancel or terminate this agreement as provided herein or given by law, the provisions of this agreement shall be binding upon and shall inure to the benefit of the Railroad, its successors and assigns, and to the benefit of the Government and its assigns.

10. The obligations of the Government hereunder shall not extend beyond the appropriations available or which may be available therefor.

11. It is further mutually agreed that no Member of or Delegate to Congress or Resident Commissioner after his election or appointment and either before or after he has qualified, and during his continuance in office, shall be admitted to any share or part of this contract or agreement, or to any benefits to arise therefrom. Nothing, however, herein contained shall be construed to extend to any incorporated company where such contract or agreement is made for the general benefit of such incorporation or company.

IN TESTIMONY WHEREOF, the parties hereto have caused this agreement to be executed in duplicate on the day and year first above written.

Witnesses:

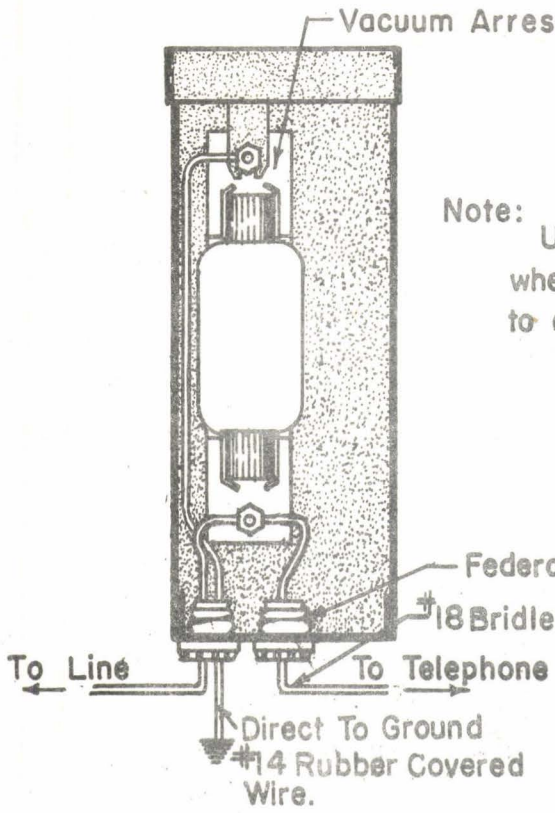
_____ _____

_____ By_____

Witnesses:

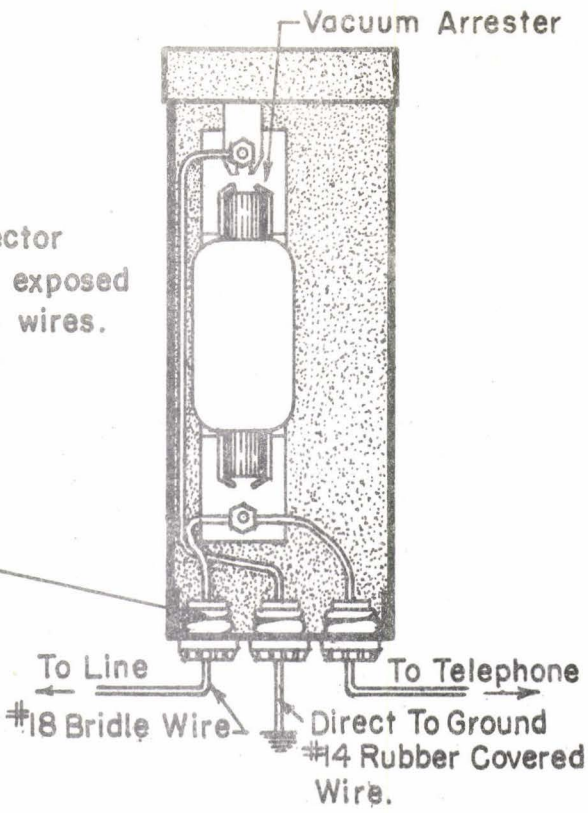
_____ UNITED STATES OF AMERICA

_____ By_____

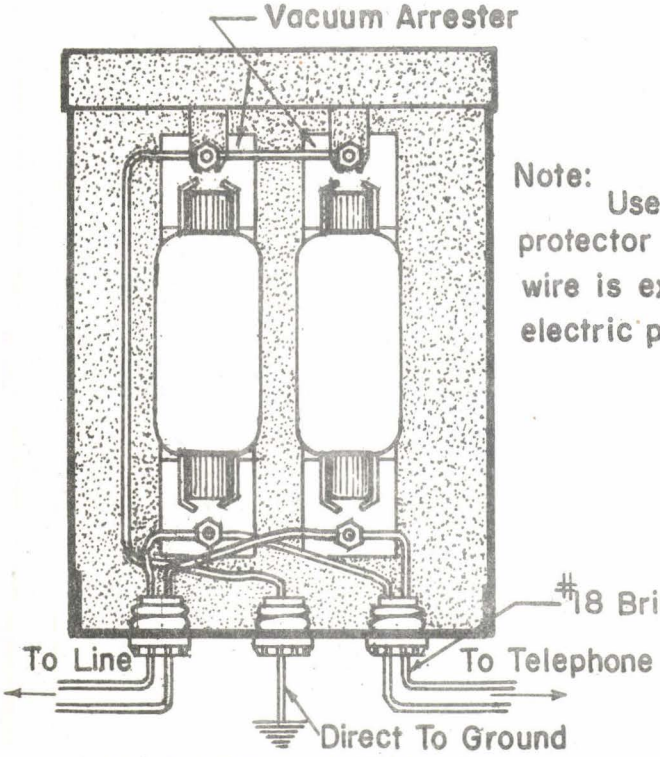


OVERHEAD SERVICE
GROUNDED CIRCUIT

Note: Use 99-A protector where line wire is exposed to electric power wires.

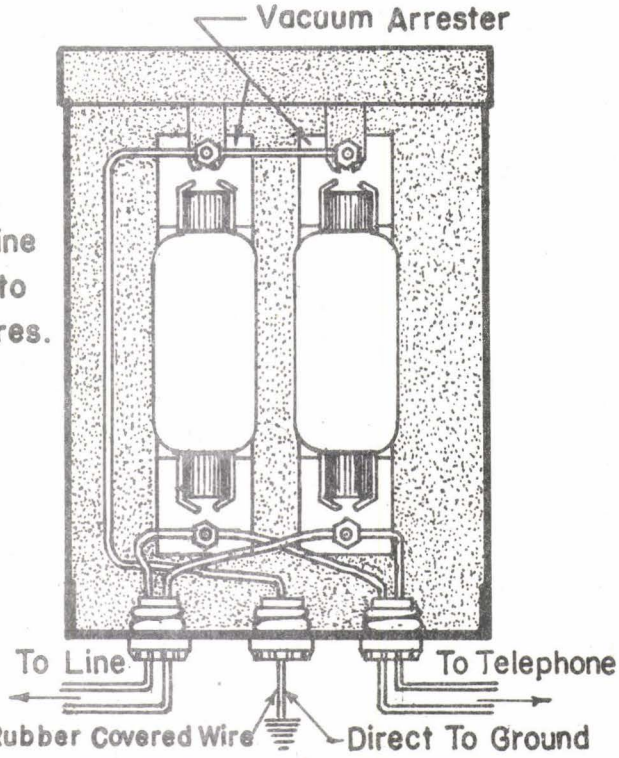


UNDERGROUND SERVICE
GROUNDED CIRCUIT



OVERHEAD SERVICE
METALLIC CIRCUIT

Note: Use 99-A protector where line wire is exposed to electric power wires.



UNDERGROUND SERVICE
METALLIC CIRCUIT

VACUUM ARRESTER INSTALLATION

CONSTRUCTION AND REPAIRS

All on-the-job orders are to be given by the foreman in direct charge.

Climbing

(a) Examine poles (especially at the ground line for rot) for safe condition before climbing. Test them by vigorous pushing.

(b) Make sure that spurs are properly fitted to the leg.

(c) Check before using to be sure lineman's equipment is in good condition.

(1) Gaffs properly sharpened and of correct length. (See appendix of Telephone Handbook for sharpening instructions. See page 312)

(2) Climbers and straps dependable and properly fitted to climber.

(3) Safety strap and belt checked for cuts, cracks, sticking, riveting, and pliability.

(d) When climbing poles or trees, take short steps, place spur and gaff forcefully where it will not slip. As each step in climbing is made, make a deliberate and forceable step with knee bowed out. Avoid cracks, knots, nails, signs, or other objects which will cause slipping. (Signs or nails should not be placed on poles.)

(e) Lineman's safety tool belt with safety strap properly adjusted to pole or tree to be climbed will be worn while off the ground. The strap should be adjusted by the lineman after he has started his climb by having both climber spurs firmly imbedded in the tree or pole.

The safety strap should not be around pole or tree while lineman is moving up or down.

(f) Don't jump from trees or poles when wearing spurs. Horseplay has no place in climbing or other line work.

(g) Use extreme caution when climbing icy, frozen, cracked knotty, rotten, crooked, case hardened, or especially soft poles or trees.

(h) Never climb a pole which has a metal or wooden sign on it until the sign has been removed.

(i) It is advisable to wear serviceable work gloves while climbing.

Working Aloft

(a) Safety straps should be fastened at all times when working aloft.

(b) Cross arms, braces, pins, and small limbs should not be used for support. Use a safety strap around that portion of the pole above the top crossarm only when the pole is 15 inches or more higher than the crossarm.

(c) Use hand lines to pass tools, equipment, and materials to and from lineman or to rehand wire in insulators.

(d) Ground workers shall keep out from underneath tree or pole workers.

Inspection

(a) Inspect lineman's belt for worn, hard, or dry leather, worn or broken sewing, loose rivets, worn buckles, rollers and tongues. Replace when in doubt.

(b) See that gaffs are kept sharp and pole spurs are replaced when gaffs are less than 1-1/8 inches long (measured on the under side). Discard tree spurs when less tham 3 inches long.

Equipment

(a) It is generally safer to use pole spurs on small, thin barked trees. Tree spurs should be used for rough, thick barked trees.

(b) Use of steel core safety rope is optional.

(c) Don't use substitute material, such as ropes, wire, etc., for temporary repairs. Obtain new parts.

(d) Safety belts and straps shall not be spliced.

Maintenance

Guard against"flip" when wire is cut or released from overhanging trees, branches, stumps, etc. Guard eyes against loose wire ends.

POLES

Loading and Transporting

(a) Provide substantial, non-slipping, and well-braced skids where hand loading is necessary. Eliminate heavy lifting.

(b) Loading with power equipment. (See section Gin Poles. Page 74.

(c) When hauling poles, except after distribution has started along pole right-of-way, see that they are securely chained while vehicle is in motion. Attach red flag to rear end of longest pole. Prohibit riders on pole loads, and men walking by side of load while poles are being distributed.

(1) No one should ride on top of load of poles and no one whose presence is not required should stand on load when unloading and distributing poles.

(2) Do not wear climbers when working on stepped poles, when using ladder, or when working on the ground.

(3) Do not work with line wire during an overhead or nearby electrical storm.

Raising

(a) Inspect pike poles and arches (hook ladders) for serviceable condition.

(b) When raising long poles, extend holding lines from near their tops in order to steady them.

(c) Hold poles with two peavies to prevent roll when being raised with pike poles.

(d) Line wires from a pole should not be cut without first guying or bracing, if there is danger of a pole falling.

(e) Do not stand on butt of pole to force it into the hole when pole is being raised.

(f) Keep in the clear when a man is working on the pole.

TREE LINES

Do not work or loiter under trees which are being limbed. Exercise great care when limbing a tree to avoid cutting safety belt line. Examine all hand lines frequently to insure their soundness at all times. Use pruning saws wherever possible. Extensions are a valuable aid.

WIRE

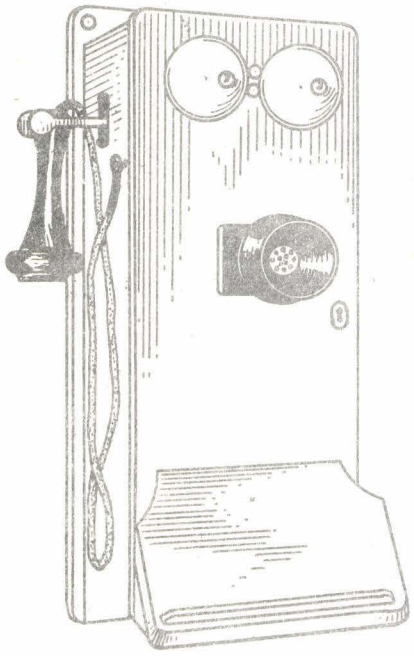
Stringing Wire

In using come-alongs, be sure to be in the clear so that in case of slip or breakage, the ends of the wire will not whip against you.

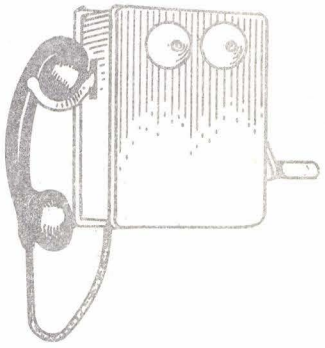
Do not wear climbers for work on the ground.

Hanging Wire

In working on lines paralleling high voltage lines, wear rubber gloves and use insulated tools, as these lines often become charged with static electricity. When repairing breaks on such lines, ground the line on both sides of the break before starting work. Line workers should not contact wire during overhead or nearby lightning storms. Use chains to ground a line by throwing a chain over the wire on each side of the break and securing it to the ground by a bar pick or similar tool.



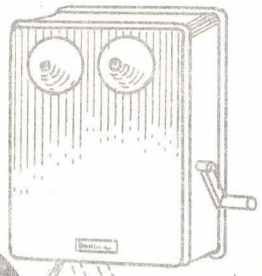
LONG WALL TYPE
(Batteries in Telephone Case)

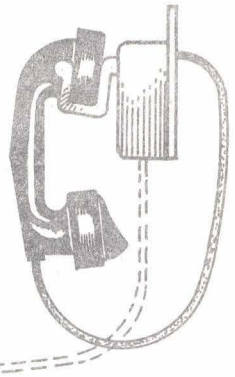


SHORT WALL TYPE
(Batteries Seperate)

GENERATOR AND BELL BOX
(Similar to short wall type,
less hook switch on box)

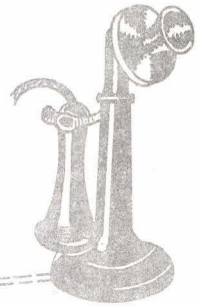
May be used with
any of the three
instruments shown





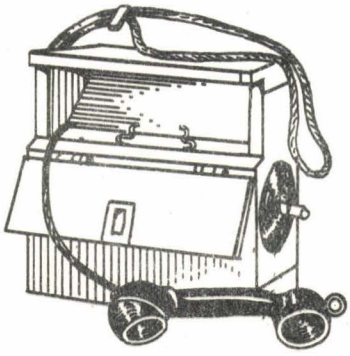
DESK OR WALL
PHONE
(1)

DESK CRADLE
WITH HAND SET
(2)

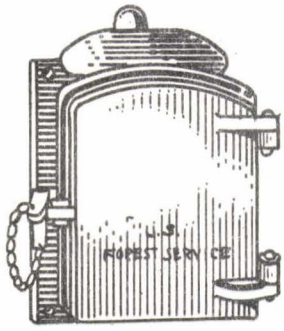


DESK STAND
PHONE
(3)

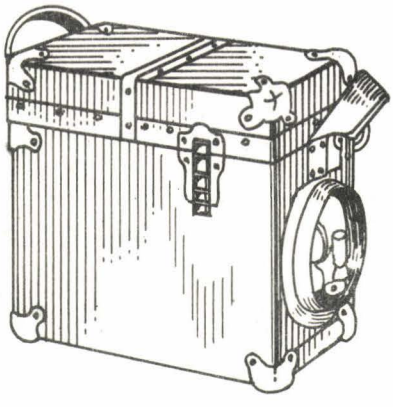
TELEPHONE INSTRUMENT TYPES



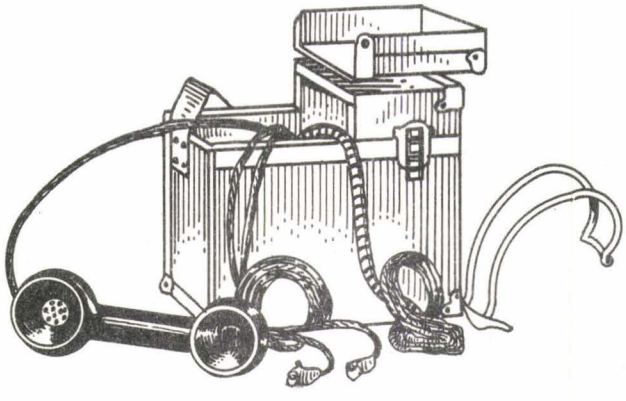
PORTABLE TELEPHONE
Kellogg Model C



MINE TYPE



WEST TEST SET
(Closed)



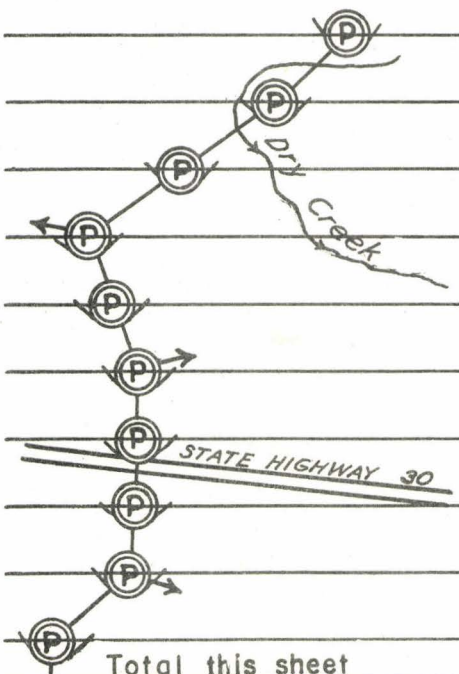
WEST TEST SET
(Open)

TELEPHONE INSTRUMENT TYPES

Form ※ ..... Sheet ..... of ..... Sheets

..... Communication System

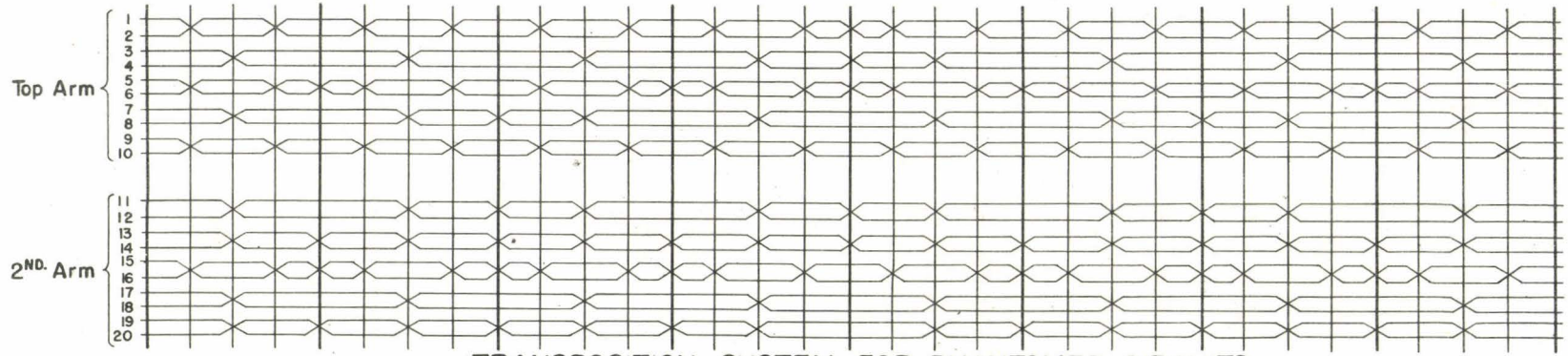
Name of Line ..... Line Number .....

Location Diagram, Pole, Stubs, Guys, Crossarms and Brackets	Pole No.	Span Length in ft.	Length and Species of Pole	Station	Angle (degrees)	Reinforced	Year set	R W File	
	9	264	Pine 20	17+78	—	No	1939	1938	
	8	264	Pine 20	15+14	—	No	1939	1938	
	7	264	Pine 20	12+50	20°	No	1939	1938	
	6	212	Pine 20	9+86	—	No	1939	1937	
	5	212	Pine 20	7+74	20°	No	1943	1937	
	4	212	Pine 30	5+62	—	No	1939	1937	
	3	175	Pine 30	3+50	—	No	1939	1935	
	2	175	Pine 20	1+75	15°	No	1939	1935	
	1		Pine 20	0	—	No	1939	1935	
Total this sheet									
Brought forward									
Accumulated Total				Carried forward					

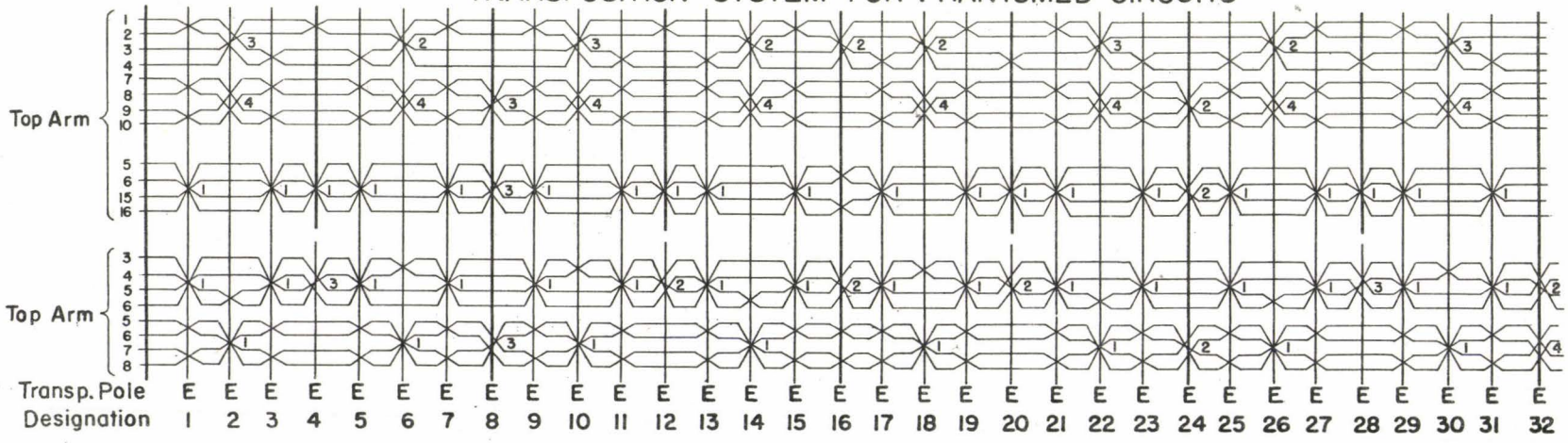
"E" SECTION

TRANSPOSITION SYSTEM FOR NON-PHANTOMED CIRCUITS

For lengths between 41,600 feet and the minimum distance which will permit of the necessary number of transposition poles.



TRANSPOSITION SYSTEM FOR PHANTOMED CIRCUITS



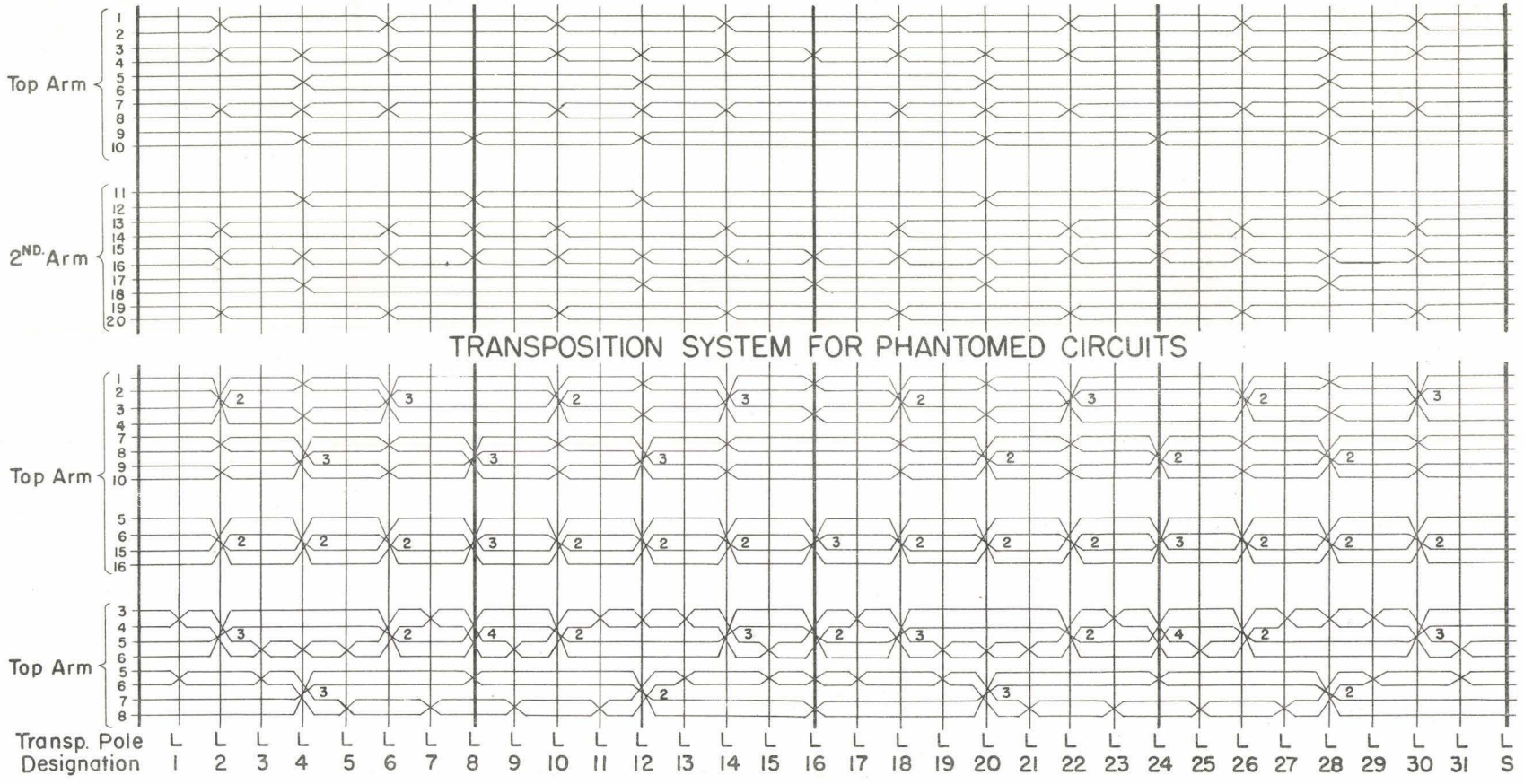
NOTES: Line transposed in direction of arrow ▬▬▬▶

The figure at each phantom transposition indicates the type. Space as regularly as possible.

"L" SECTION

TRANSPOSITION SYSTEM FOR NON-PHANTOMED CIRCUITS

For lengths between 20,800 feet and the minimum distance
which will permit of the necessary number of transposition poles.


Top Arm
2ND. Arm
TRANSPOSITION SYSTEM FOR PHANTOMED CIRCUITS
Top Arm
Top Arm
Transp. Pole Designation
L 1 L 2 L 3 L 4 L 5 L 6 L 7 L 8 L 9 L 10 L 11 L 12 L 13 L 14 L 15 L 16 L 17 L 18 L 19 L 20 L 21 L 22 L 23 L 24 L 25 L 26 L 27 L 28 L 29 L 30 L 31 L S

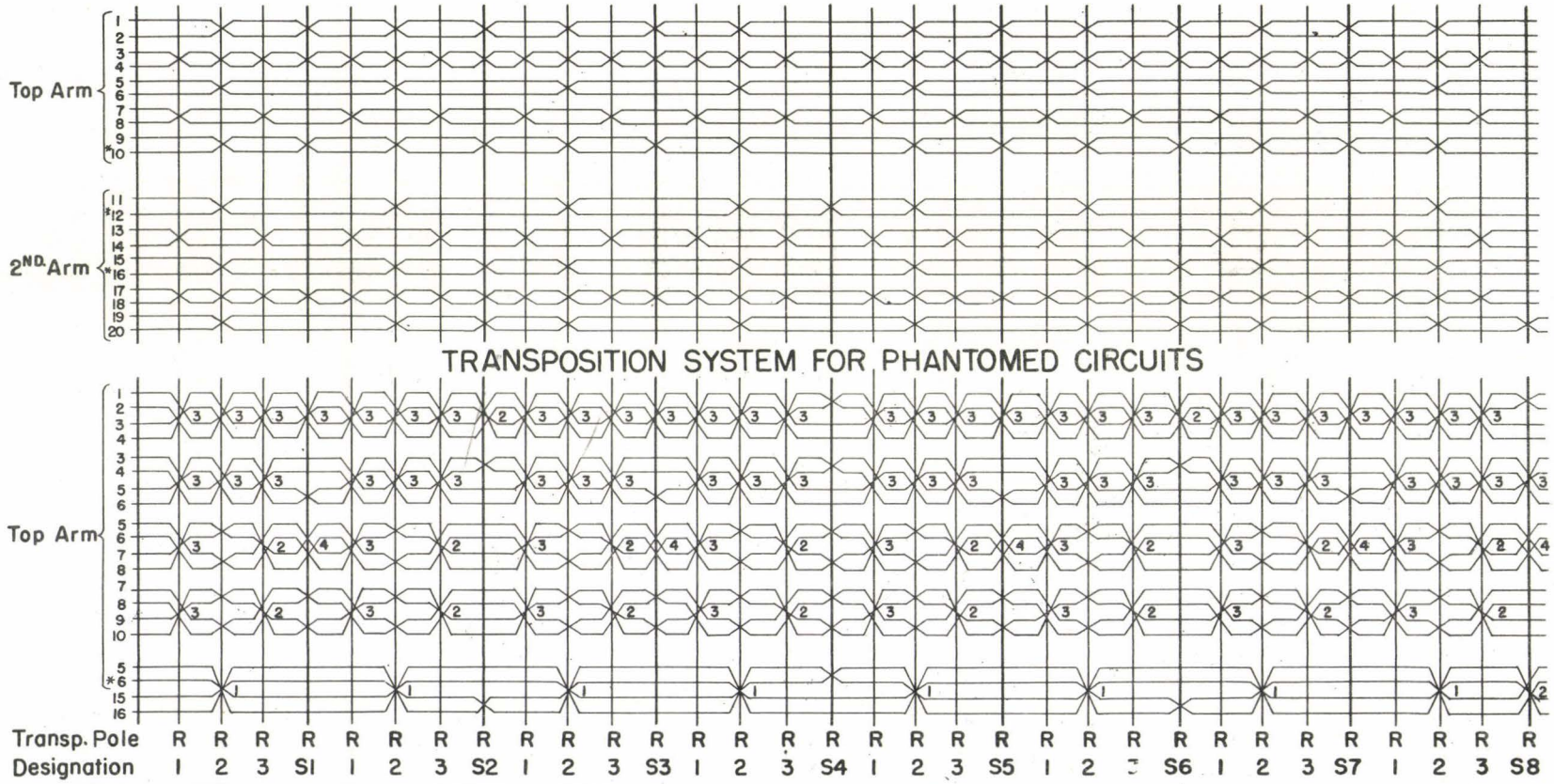
NOTES: Line transposed in direction of arrow ⟶

The figure at each phantom transposition indicates the type. Space as regularly as possible.

"R" SECTIONS

TRANSPOSITION SYSTEM FOR NON-PHANTOMED CIRCUITS

Maximum length of one R section is 2640 feet.

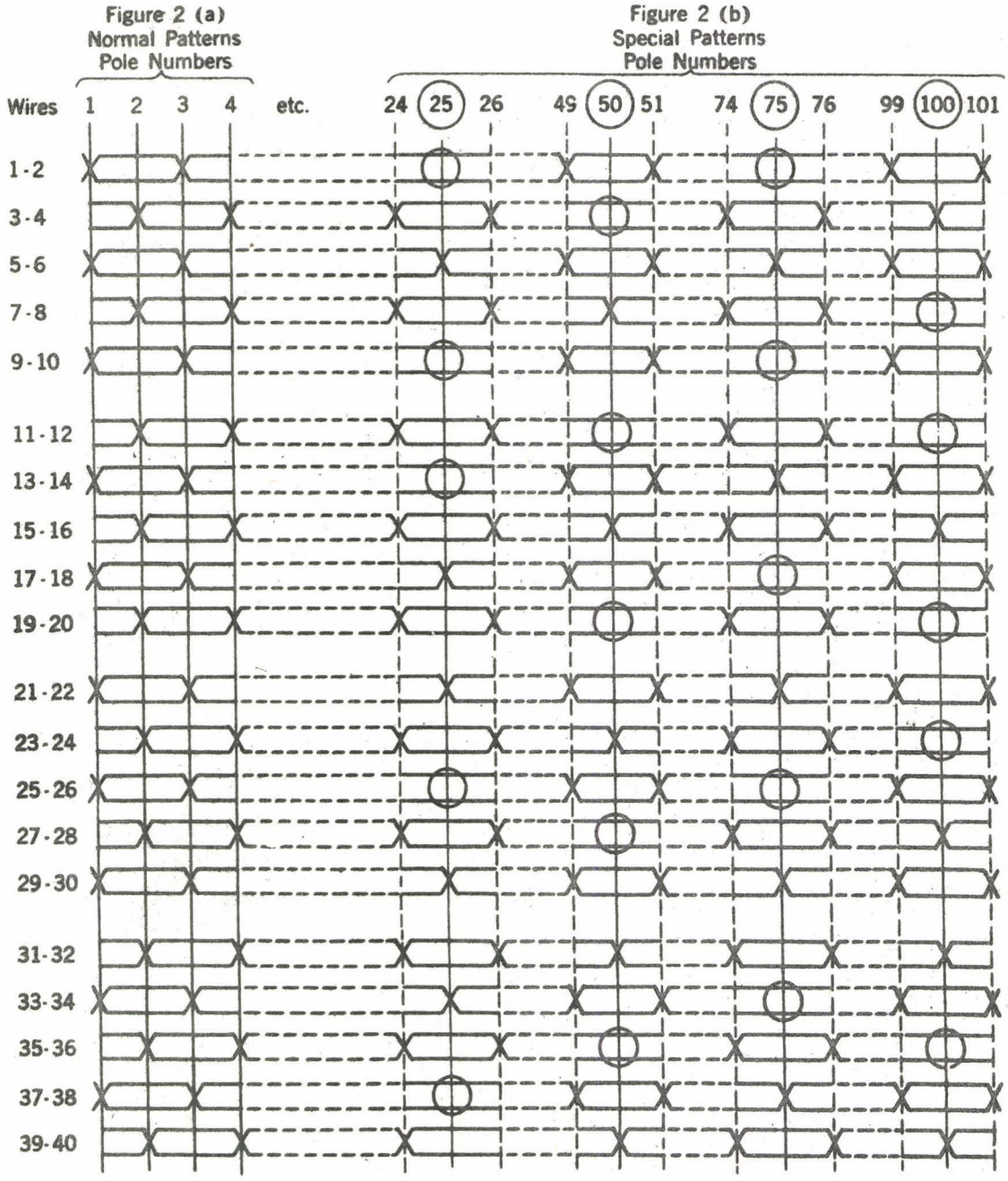

Top Arm
2ND Arm
TRANSPOSITION SYSTEM FOR PHANTOMED CIRCUITS
Top Arm
Transp. Pole R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R
Designation 1 2 3 S1 1 2 3 S2 1 2 3 S3 1 2 3 S4 1 2 3 S5 1 2 3 S6 1 2 3 S7 1 2 3 S8

NOTES: Line transposed in direction of arrow ➡

The figure at each phantom transposition indicates the type.

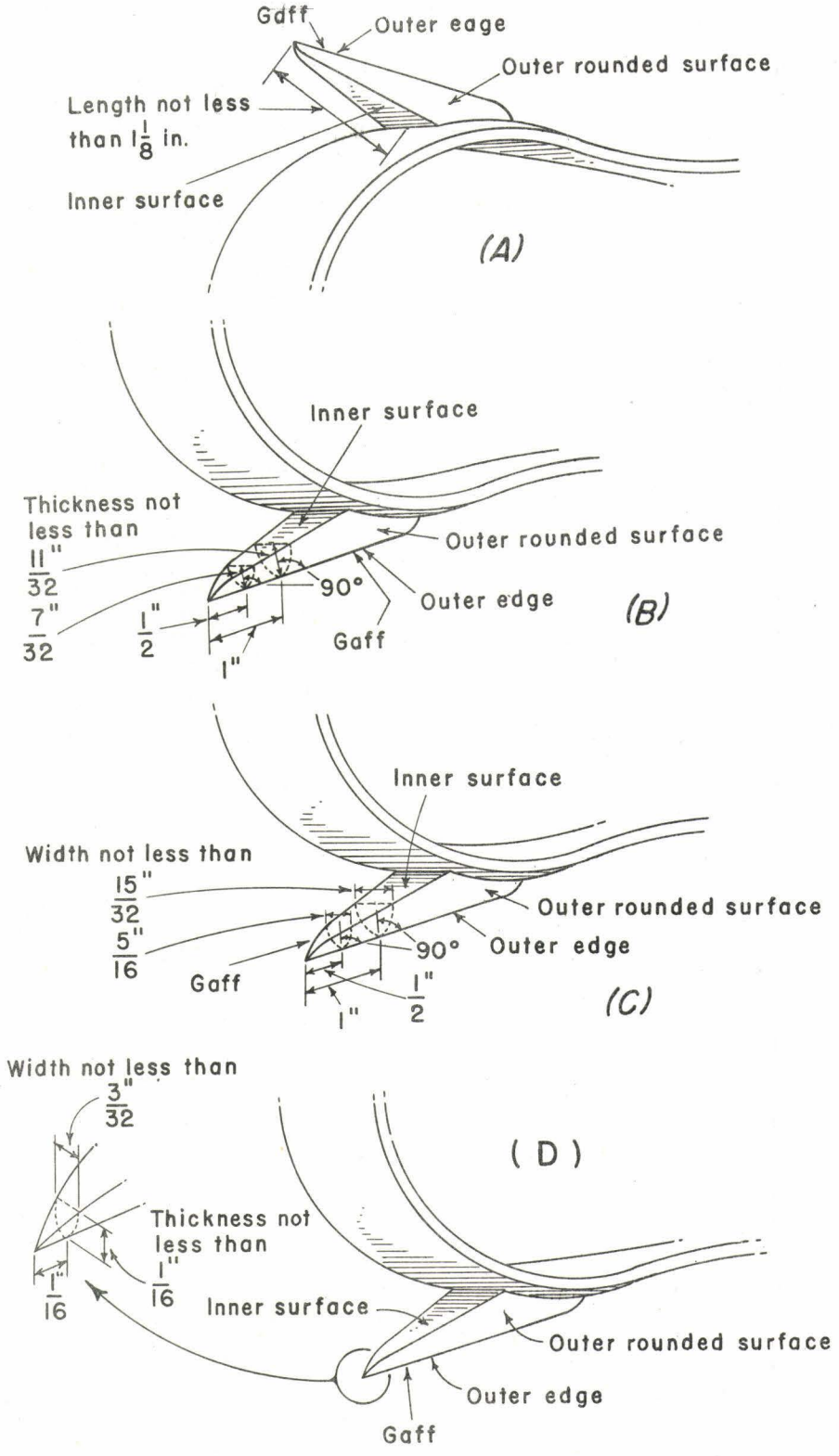
* Indicates pair not transposed in the X section of the "Standard" system.

R1 TRANSPOSITION DESIGN
Arrangement of Transpositions *



* This design can be used on either 2-4-6-8 or 10-pin crossarms as noted in the text.

◯ Indicates transposition omitted.



MINIMUM DIMENSIONS TO WHICH GAFFS OF LINEMEN'S CLIMBERS MAY BE SHARPENED

STRUCTURAL SYMBOLS

= Round pole - untreated

= Round pole - treated (Insert (P) for pressure treatment in circle)

= Sawed pole - untreated

= Sawed pole - treated (Insert (P) in square for pressure treated timber)

= X frame - untreated

= X frame - treated (Add (P) at side of symbol for pressure treated timber)

= Pole with four brackets (Indicate correct number of brackets)

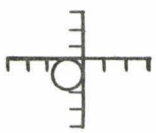
= Pole with 6-pin crossarm (Indicate correct number of pins)

= H structure with 6 pins (Indicate correct number of pins)

= Side guy with screw or cone anchor

= In-line guy with log or plank anchor. RA at end of symbol indicates rock anchor.

= Double crossarm (Indicate correct number of pins)

 = Buck arm (Indicate correct number of pins)

= Crossarm with back truss (Indicate number of pins)

= Dead-end (Indicate correct number of pins; add UG where underground is used)

T P Test point

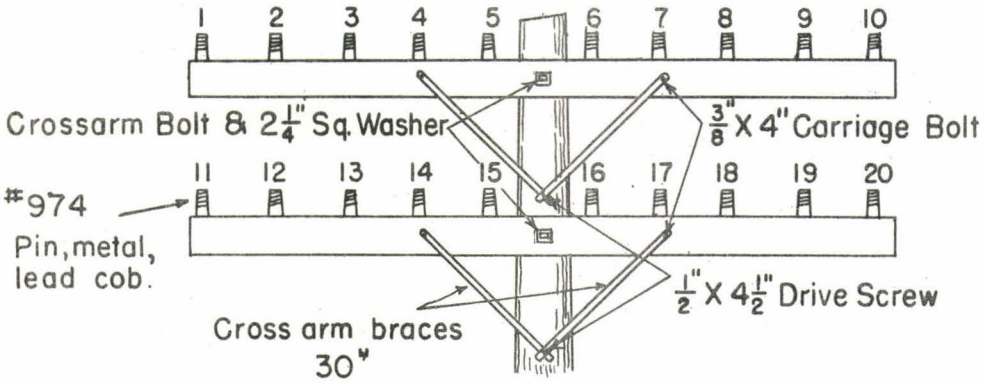
INSTRUMENT SYMBOLS

= Repeaters

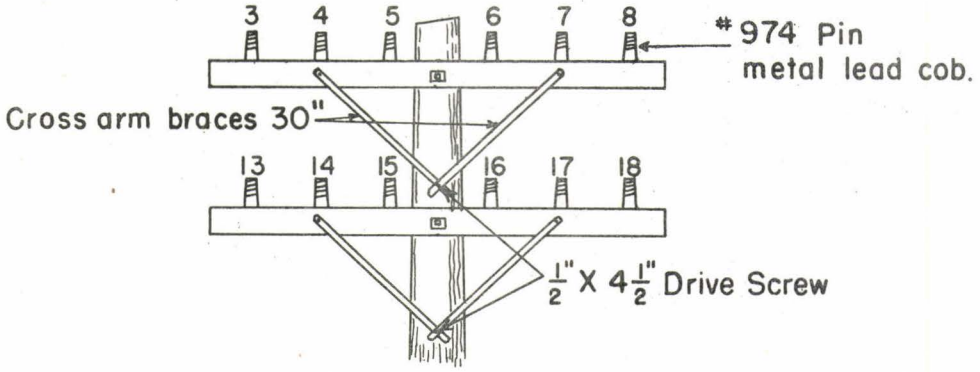
= Repeat coils

= Lightning protection

T = Telephone instrument


1 2 3 4 5 6 7 8 9 10
Crossarm Bolt & 2¼" Sq. Washer
⅜" X 4" Carriage Bolt
11 12 13 14 15 16 17 18 19 20
#974
Pin, metal, lead cob.
½" X 4½" Drive Screw
Cross arm braces 30"

10 PIN CROSSARM



6 PIN CROSSARM

PIN POSITIONS

INDEX OF ILLUSTRATIONS

Page

ALIGNMENT, pole 71
Anchor, cone type 53
Anchor, log 52
Anchor, log brace 101
Anchor, plank 52
Anchor, rock 54
Anchor, steelwing 53
Angle plate 98
Arm, channel 93
Arm, reverse (Buck) 91
Arm, extension 88
Arrangement of brackets 95
Arrester, ball-gap 44
Arrester, gap, spur line junction pole 206
Arrester, lightning, type B 210
Arrester, lightning, type C 203
Arrester, location, terminal pole 205
Arrester, vacuum 300

BLOCK, snatch 58
Brace, crossarm 116
Brace, push pole 99, 100
Bracket arrangement 95
Bracket clip 96
Bracket construction, power protector 214
Bracket installation 97
Bracket line, dead-ends 163
Bracket, phantom 151
Bracket, R' transposition 98
Bracket, terminal 89
Bracket, wood 96
Building fixtures, drop wire 181
Buildings, entrance, 2 or more circuits 179

CABLE hanger 172
Cable terminal pole 109
Cable, underground, and grounding leads 193
Channel arm 93
Chemical treatment of ground 199
Choker hook 58
Climber gaff dimensions 312
Clip, bracket 96
Compression tool 285
Cone type anchor 53

Page

Crib, rock 34
Crossarm 83
Crossarm brace 112
Crossarm construction, power protector 214
Crossarm, double 87
Crossing, highway, railroad, waterway 122
Crossarm, location 80
Crossarm, raising 85
Crossarm, 6 or 10 pin 311
Crossarm, 6 - pin, long span 94
Crossarm, 10 - pin, long span 94
Crossarm, wire stringing rope hold 127

DEAD-END fixture 94
Dead-end, long span, tree line 36
Dead-end, normal span, tree line 35
Dead-end tie, tree line 38
Dead-ends, pole bracket line 163
Desk cradle with hand set, telephone 305
Desk telephone 305
Double tie, tree line 38
Drop wire, building fixtures 181
Drop wire construction 174
Drop wire entrance 174

ENTRANCE, building, from carbon block arrester 182
Entrance, buildings, 2 or more circuits 179
Entrance, drop from main line 183
Entrance drop from single line, terminal pole 183
Entrance, drop wire 174
Entrance, overhead 180
Entrance, steel or wood tower, 2 or more circuits 189
Entrance, steel tower, single circuit 190
Extension arms 88

FIXTURE, dead-end 94
Framing, standard 70

GAFFS, minimum dimensions 312
Gap arrester 44
Gap arrester and cut-off switch, spur line junction pole 206
Gap arrester location, terminal pole 205
Gauge, sag 135, 136
Generater and bell box, telephone 305
Grip-flex snubbing tie 42

Page

Ground and metallic lines, terminal pole 205
Ground, chemical treatment 199
Ground circuit, spur line, lightning protection 207
Ground conductor 112
Ground testing 201
Grounding leads, underground cable 193
Grounds, multiple rod chart 198
Guy, corner-pole pull 103
Guy, head or back 102
Guy installation 105
Guy insulators 107
Guy, span 106
Guys, side or storm 104

H-FRAME 92
H-frame, channel arm 93, 94
Hanger, cable 172
Highway crossing 122
Hook, choker 58

INSTRUMENT symbols 313
Insulator, strain, make-up 107
Insulators, guy 107
Intermediate pole cable attachment 173

KELLOGG Model C telephone 306

LAYOUT, overhead 167
Lightning arrester, type B 210
Lightning arrester, type C 203
Lightning arrester switch, terminal pole 211
Lightning conductor, pole 112
Lightning protection, spur line ground circuit 207
Line, binding, with choker hooks 58
Line, binding, with wire rope snatch blocks 58
Line, metallic, protection 204
Line splicing 131
Line wire reel 117
Line wire, transposition R1 147
Location sheets 307
Log anchor 52
Long wall type telephone 305

METALLIC and ground lines, terminal pole 205

Page

Metallic circuit, spur line, lightning protection 207
Mine type telephone 306

NICOPRESS tool 285
Nonphantom circuits, "E" section 308
Nonphantom circuits, "L" section 309
Nonphantom circuits, "R" section 310
Numbering, pole 110

OVERHEAD layout 167

PHANTOM bracket 151
Phantom circuits, "E" section 308
Phantom circuits, "L" section 309
Phantom circuits, "R" section 310
Phantom transposition, type 1 152
Phantom transposition, type 2 153
Phantom transposition, type 3 154
Phantom transposition, type 4 155
Pin, tree, iron 40
Pins, position 314
Plank anchor 52
Plate, angle 98
Pole brace, anchor log 101
Pole brace, push 99, 100
Pole bracket line, dead-ends 163
Pole cable attachment, intermediate 173
Pole, cable terminal 109
Pole facing, dead-end 81
Pole facing, long span 82
Pole facing, single corners 80
Pole facing, 2-pole corner, alternate 82
Pole facing, 2-pole corner, standard 81
Pole grading, vertical alignment 71
Pole, junction, with gap arrester and cut-off switch 206
Pole lightning conductor 112
Pole numbering 110
Pole setting, gin-pole method 75
Pole setting, hand method 73
Pole setting, water-jet method 77
Pole splicing 69
Pole, terminal 176, 184
Pole tie 37
Pole-head pattern, R 1 transposition 148
Poles, corner, rake 79
Poles, unloading on flatcar 58, 61
Power and telephone joint construction 169

Page

Power protector, bracket construction 214
Power protector, crossarm construction 214

R 1 TRANSPOSITION 145
R 1 transposition, corner wire position 146
R 1 transposition, line wire 147
R 1 transposition, pole-head pattern 148
Railroad crossing 122
Rake, corner poles 79
Reducing sleeve 184
Reel, line wire 118
Repeating coil connection, wiring 221, 222, 223
Reverse arm (Buck) 91
Rock anchors 54
Rock crib 34
Running board, transposition 118

SAG gauge 135, 136
Short wall type telephone 305
Side guy 104
Signals, hand 119
Six pin crossarm 311
Slack pulling double equalizer assembly 128
Sleeve, dead-end 186
Sleeve, gauge 133
Sleeve, reducing 184
Sleeve, repair 272
Sleeve, table 253
Sleeves, tap 185
Sling, "V" 64
Snatch block 58
Snubbing methods, alternate 134
Span guy 106
Splicing, drop, bridle, inside wire 185
Splicing, line 131
Splicing, pole 69
Splicing tools 132, 133
Split tree insulator 45
Spur line ground circuit, lightning protection 207
Spur line junction pole with gap arrester and cut-off switch 206
Standard framing 70
Stapling 39
Steel or wood tower entrance, 2 or more circuits 189
Steel tower entrance, single circuit 190
Steelwing anchor 53
Storm guy 104
Storm loading areas, U. S. 137

Page

Strain insulator make-up 107
Stubbing methods 69
Switch, lightning arrester, terminal pole 211
Symbols, structural and instrument 313

TAP sleeves 185
Telephone and power joint construction 169
Telephone, desk cradle with hand set 305
Telephone, desk or wall 305
Telephone, generator and bell box 305
Telephone, Kellogg Model C 306
Telephone, long wall type 305
Telephone, mine type 306
Telephone, short wall type 305
Telephone, tower cab 188
Telephone, West test set 306
Ten pin crossarm 311
Terminal bracket 89
Terminal pole 176
Terminal pole, lightning arrester switch 211
Terminal pole metallic and ground lines 205
Terminal pole, 1 metallic and 1 ground circuit return 184
Terminal pole, 2 entrance drops from single line 183
Test station 165
Testing, ground 201
Tie, Grip-flex snubbing 42
Tie, pole 37
Tie, tree line 37
Tie, tree line, dead-end 38
Tie, tree line, double 38
Ties, tree, selection of 31
Tool, nicopress 285
Tools, splicing 132, 133
Tower cab control, lightning arrester switch 211
Tower cab telephone installation 188
Transposition, phantom, type 1 152
Transposition, phantom, type 2 153
Transposition, phantom, type 3 154
Transposition, phantom, type 4 155
Transposition R 1 ..... 145, 311
Transposition R 1, corner wire position 146
Transposition R 1, pole head pattern 148
Transposition running board 118
Transposition system, "E" section, phantom and nonphantom circuits 308
Transposition system, "L" section, phantom and nonphantom circuits 309
Transposition system, "R" section, phantom and nonphantom circuits 310
Tree insulator, split 45
Tree line tie 37

Page

Tree pin, iron 40
Tree ties, selection 31
Tripod 34
Tying wire 156, 162

UNDERGROUND cable and grounding leads 193
Unloading poles from flatcar 58, 61

"V" SLING 64

WALL telephone 305
Waterway crossing 122
West test set, telephone 306
Wire stringing, crossarm rope hold 127
Wire tying 156, 162
Wiring, repeating coil 222
Wood bracket 96

INDEX

	Page
ABANDONMENT of communications facilities	6
Agreement forms	296
Agreements, right-of-way	9
Alley arms	87
Anchor holes	51
Anchors, cone	52
Anchors, log	51
Anchors, plank	51
Anchors, rock	54
Anchors, steelwing	52
Angle tie, tree line	38
Appendix	301
Arrester, gap	44
Arrester, gap, grounding conductor	205
Arrester, gap, grounds	208
Arresters	247
Arresters, ball-gap	203
Arresters, carbon block-type	208
Arresters, lightning	203
Arresters, vacuum-type	209, 300
Attachments, poles	83
BACKFILLING	79
Ball-gap arresters	203
Batteries	225
Belt, body, and safety strap	278
Binding line	58
Block, snatch	58
Boundary changes, determination	14
Braces, crossarm	113
Braces, push pole	99
Bracing	99
Bracing, ground	101
Bracket arrangement, R 1 transposition	98
Bracket, terminal, installation	89
Bracket, wood	96
Brackets	95
Brackets, transposition	150
Bridle wire, splicing	185
Brush disposal, pole line	48
Brush disposal, tree line	43
Buck arm	90
Building fixtures, drop wire	181
Burns, creosote	55

	Page
CABINETS, terminal	177
Cable ring	173
Cable system, overhead, route selection	168
Cable terminal pole	109
Cables, messenger, entrance construction	170
Carbon block-type arresters	208
Charges for facilities use	11
Chemical treatment of ground	199
Choker hook	58
Circuit noise	268
Circuits, telephone, maintenance	265
Clearances	118
Clearing, pole line	47
Clearing, tree line	43
Climbers, gaff dimensions	312
Climbers, lineman's, maintenance	277
Coils, repeating	220
Coils, repeating, tests	221
Communication facilities, abandonment	6
Communication facilities, construction	6
Communication methods, integration	5
Communication organization	2
Communication plan objective, retaining	7
Communication policy	1
Communications committee, Regional	2
Communications, cooperation	12
Communications, effect of special-use permits	12
Communications officer, Forest	3
Communications officer, Regional	3
Communications, planning	13
Compression tools, adjustment	284
Conductors, contact with other conductors	270
Conductors, ground, for pole protection	111
Conductors, longitudinal unbalance in	270
Cone anchors	52
Connections, dropwire	173
Connections, temporary	130
Construction, communications facilities	6
Construction, metallic vs. ground return	5
Construction, pole line	46
Construction, safety precautions	301
Construction, tree line	30
Construction, tree line, crew	44
Cooperation in communications	12
Copper-covered steel wire	217
Copper wire	216
Corner poles, rake	78
Costs, recurrent	26
Creosote burns	55

	Page
CREW, tree-line, size	44
Crib, rock	34
Crossarm braces	113
Crossarm, Buck	90
Crossarm pins	113
Crossarm, reverse	90
Crossarm, 6 pin	311
Crossarm, 10 pin	311
Crossarms	83
Crossarms, attaching	83
Crossarms, double	86
Crossarms, extension (alley)	87
Crossings	118
Crossings, light wire	124
Crossings, power wire	124, 125
Crossings, railroad	121, 122
Crossings, streets, highways, and roads	121, 122
Crossings, trolley wire	124
Crossings, waterway	121, 122
Cross-talk	271
Culverts, as grounds	197
DATA, planning, on record	28
Dating, pole	108
Dead end, long span, tree line	36
Dead end, normal span, tree line	35
Dead-ending wires	163
Development, technical, centralized	9
Diagrams, distribution	26
Diagrams, switchboard	26
Diagrams, terminal	26
Disconnect switches, grounding type	209
Disconnects, line and instrument	212
Distribution diagrams	26
Distribution, lines	166
Distribution, poles	67
Double crossarm	86
Double tie, tree line	38
Downhill grade snubbing	41
Drainage transformers	212
Drop wire, building fixtures	181
Drop wire, connections	173
Drop wire construction	174
Drop wire, on messenger cable	171
Drop wire, splicing	185

Page

"E" SECTION, transposition systems 308
Easement forms 296
Easements 9
Entrance, building, from carbon block arrester 182
Entrance construction 186
Entrance construction, buildings 180
Entrance construction, erecting poles 170
Entrance construction, heavy loading 187
Entrance construction, light loading 187
Entrance construction, material listing. 170
Entrance construction, messenger cables. 170
Entrance construction, overhead 168
Entrance construction, tower 189, 190
Erecting poles, hand 72
Estimates, labor cost and time 25
Estimates, material and cost 25
Extension arms 87

FACING, pole 80
Flatcars, unloading 60
Forest Communications officer. 3
Frames, H 92
Framing poles 70
Frequencies, assignment 8
Frequencies, use 8
Freezing of grounds 197
Fuses, line 212

GAFF dimensions 312
Gaffs, sharpening 277, 312
Galvanized iron wire 216
Gap arrester 44
Gap arrester, grounds 208
Gap arrester locations 205,206, 207
Gin pole, pole setting 74
Gripflex snubber 41
Ground, chemical treatment 199
Ground resistance values 200
Grounding conductor, gap arrester 205
Grounding systems 194
Grounding-type disconnect switches 209
Ground-return lines, noise 271
Ground-return vs. metallic construction 5
Grounds 196
Grounds, caution 196
Grounds, culverts 197
Grounds, freezing 197

	Page
Grounds, gap arrester	208
Grounds, metallic objects	196,197
Grounds, multiple rods	198
Grounds, pole protection	111,202
Grounds, sewage systems	197
Grounds, testing	200
Grounds, water systems	196
Guards, guy	108
Guy, back	102
Guy, head	102
Guy insulators	107
Guy shields (guards)	108
Guy, side	104
Guy, span	106
Guy, storm	104
Guying	102
Guys, corner-pole pull	103
H FIXTURES	92
H Frames	92
Handling poles	55
Hanging wire	39
Headquarters, future, determinations	14
Highway crossings	121,122
Holes, anchor	51
Holes, pole	49
Holes, pole, depth	50
Hook, choker	58
INSTRUCTION, letters	26
Instrument disconnects	212
Instrument maintenance	273
Instrument protection	203
Instrument symbols	313
Instruments, telephone	218,305
Insulating transformers	212
Insulator placing	114
Insulator, split tree	45
Insulator, strain, make up	107
Insulators	113
Insulators, guy	107
Iron tree pin	40
Iron wire, galvanized	216
JUNCTIONS, terminal, inside	178
Junctions, terminal, outside	177

Page

"L" SECTION, Transposition systems 309
Labor cost estimates 25
Lending radio equipment 8
Letters of instruction 26
Light wire crossings 124
Lightning arresters 203
Lightning protection 44
Line, binding 58
Line construction, tree 30
Line disconnects 212
Line fuses 212
Line location, pole 21
Line location, tree 30
Line loading 215
Line protection 202
Line wire, dead-ending 164
Line wire, electrical characteristics 261
Line wire, physical characteristics 261
Line wire, repair sleeves 272
Line wires, tying 156
Lines, distribution 166
Lines, ground-return 5
Lines, location in relation to esthetic values 10
Lines, metallic 5
Loading, line 215
Loading poles 56
Location, pole line 21
Location sheets 307
Location, tree line 30
Log anchors 51

MAINTENANCE, body belt and safety strap 278
Maintenance, climbers 277
Maintenance, pole line 267
Maintenance, special equipment 277
Maintenance, telephone circuits 265
Maintenance, telephone instrument. 273
Maintenance, tool 281
Maintenance, tree lines 265
Manufacturers, list 286
Material estimates 25
Materials, general 226
Materials, list 227
Materials, tree line 45
Messenger cables, entrance construction 170
Messenger cables, rings and drop wire 171

Page

Metallic line, protection plan 204
Metallic objects, as grounds 196, 197
Metallic vs. ground-return construction 5
Methods, communication, integration of 5

NICOPRESS tool 285
Noise, circuit 268
Noise, ground-return lines 271
Numbering, pole 110

OVERHEAD cable system, route selection 168
Overhead construction, entrance 168

PAINTING, pole 108
Phantom transpositions 150
Pin, position 314
Pin, tree, iron 40
Pins, crossarm 113
Plan, preparation 17
Plank anchors 51
Planning communications 13
Planning data, consideration 15
Planning requirements, minimum 3
Plans, working 18
Pole bracing, ground 101
Pole, cable terminal 109
Pole dating 108
Pole dimension tables 244
Pole erecting, gin pole 74
Pole facing 80
Pole facing, open wire dead-ends 81
Pole facing, two-pole corner 81
Pole grading, vertical alignment 71
Pole hole depth 50
Pole holes 49
Pole line, brush disposal 48
Pole line, clearing 47
Pole line construction 46
Pole line location 21
Pole line, long spans 49
Pole line, maintenance 267
Pole line, short spans 49
Pole line, span lengths 48
Pole numbering 110
Pole painting 108
Pole protection grounds 111, 202

	Page
Pole, push braces	99
Pole setting, gin pole	74
Pole setting, hand	72
Pole setting, water-jet method	77
Pole splicing	69,70
Pole steps	103
Pole terminal	176,184
Pole use	66
Poles, attachments	83
Poles, backfilling	79
Poles, corner, rake	78
Poles, distribution	67
Poles, erecting	72
Poles, framing	70
Poles, handling	55
Poles, in tree lines	33
Poles, loading	56
Poles, permanent systems	66
Poles, provision for expansion	65
Poles, safety precautions	303
Poles, stacking	63
Poles, steel	68
Poles, stubbing	68
Poles, tamping	79
Poles, temporary systems	66
Poles, trucking	56
Poles, unloading	57
Poles, unloading, precautions	59
Policy	1
Power line, joint use	126
Power output to transmitters	8
Power ringing equipment	220
Power wire crossings	124,125
Preliminary survey	20
Private property, easement form	296
Protection devices	247
Protection grounds, pole	202
Protection instrument	203
Protection, line	202
Protection plan, metallic line	204
Protector #99-A	213
Pulling slack	128
"R" SECTION, transposition systems	310
R 1 transposed lines, tying	148
R 1 transposition	145

	Page
Radio, authorized use	7
Radio equipment, lending	8
Radio frequencies, assignment	8
Radio frequencies, use	8
Radio laboratory	9
Railroad crossings	121,122
Railroad right-of-way easement form	297
Rake, corner poles	78
Reducing sleeves	184
Reels	117
Regional communications committee	2
Regional communications officer	3
Repair, centralized	220
Repairs, safety precautions	301
Repeating coils	220
Repeating coils, tests	221
Resistance values, ground	200
Reverse arm	90
Right-of-way agreement form	297
Right-of-way agreements	9
Rights-of-way	19
Ringing equipment, power	220
Road crossings	121,122
Rock anchors	54
Rock crib	34
Routes, possible, determination	15
Running board, transposition	118
SAFETY	301
Safety precautions, construction	301
Safety precautions, poles	303
Safety precautions, repairs	301
Safety precautions, tree lines	304
Safety precautions, wire	304
Safety strap, and body belt	278
Sag	134
Sag gauge	136
Sag table, #6 copper-covered steel wire, long spans	143
Sag table, #8 copper-covered; heavy loading, long spans	142
Sag table, #8 copper-covered; medium and light; long spans	140
Sag table, #8 copper-covered steel wire, medium spans	142
Sag table, #8 copper-covered steel wire, short spans	141
Sag table, #10 copper-covered; heavy loading, short spans	141
Sag table, #10 copper-covered; medium and light; short spans	139
Sag table, #10 copper-covered steel wire, medium spans	140
Sag table, #12 copper-covered; heavy loading, short spans	141

Page

Sag table, #12 copper-covered steel wire, medium and light loading, short spans 139
Sag table, #8 copper wire 138
Sag table, #10 copper wire 138
Sag table, #9 galvanized iron wire 138
Sag, tree line 41
Setting poles 72
Sewage systems, as grounds 197
Shields, guy 108
Signals, wire stringing 119
Six pin crossarms 311
Slack, pulling 128
Slack, tree line 41
Sleeve, dead-end 186
Sleeve, gauge 133
Sleeves, reducing 184
Sleeves, repair, for line wire 272
Sleeves, table 253
Sleeves, tap 185
Sling, V 64
Snatch block 58
Snubber, Gripflex 41
Snubbing 41
Spacing, wire, long span, pole line 94
Span lengths, pole line 48
Span lengths, tree line 35
Span, long, tree line 36
Span, normal, tree line 35
Spans, long, pole line 49
Spans, short, pole line 49
Special-use permits, effect on communications 12
Splices, permanent 129
Splicing, bridle wire 185
Splicing, drop wire 185
Splicing, emergency 130
Splicing, inside wire 185
Splicing line wire 41
Splicing, pole 69,70
Splicing tools, table 253
Splicing wire 129
Split tree insulator 45
Stacking poles 63
Standards, adherence to 6
Stapling, tree line 39
Steel poles 68
Steel wire, copper-covered 217
Steelwing anchors 52
Steps, pole 108
Storage, tool 283
Storm loading areas 137

	Page
Storm loading, wire	136
Strain insulator make-up	107
Street crossings	121,122
Stringing wire	37,115
Stringing wire, parallel to power line	126
Stringing wire, signals	119
Structural symbols	313
Stubbing	68
Survey notes, working up	23
Survey, preliminary	20
Survey procedure	22
Switchboard diagrams	26
Switchboards	218
Switches, grounding-type disconnect	209
Symbols, instrument	313
Symbols, structural	313
Systems, permanent, poles	66
Systems, temporary, poles	66
TAMPING	79
Tap sleeves	185
Telephone circuits, maintenance	265
Telephone installation, tower cab	188
Telephone instrument maintenance	273
Telephone instrument types	305
Telephone instruments	218
Telephones	256
Ten pin crossarm	311
Terminal bracket installation	89
Terminal construction	166
Terminal diagrams	26
Terminal junctions, inside	178
Terminal junctions, outside	177
Terminal pole	176,184
Terminal strips and cabinets	177
Test stations	165
Testing grounds	200
Tests, repeating coils	221
Tests, transmission	225
Tie, angle, tree line	38
Tie, double, tree line	38
Tie trees, selection	33
Tie-ons, permission	11
Ties, tree line	37
Time estimates	25
Tool maintenance	281
Tool storage and preservation	283
Tools, compression, adjustment	284
Tools, list	288

	Page
Tools, splicing	252
Tools, tree line construction	45
Tower cab telephone installation	188
Tower, entrance construction	189,190
Transformers, drainage	212
Transformers, insulating	212
Transmission tests	225
Transmitters, power output restrictions	8
Transposition	143
Transposition brackets	150
Transposition, "E" section	308
Transposition, "L" section	309
Transposition, "R" section	310
Transposition RL	145, 311
Transposition, records for construction	25
Transposition running board	118
Transposition systems	308, 311
Transpositions	24
Transpositions, mounting on tandem brackets	149
Transpositions, phantom	150
Tree line, brush disposal	43
Tree line, clearing	43
Tree line construction	30
Tree line construction tools	45
Tree line location	30
Tree line, long span dead-end	36
Tree line, maintenance	265
Tree line, normal span	35
Tree line, normal span dead-end	35
Tree line, materials	45
Tree line, poles in	33
Tree line, safety precautions	304
Tree line, span lengths	35
Tree pin, iron	40
Trees, tie, selection	33
Tripods	34
Trolley wire crossings	124
Trucking poles	56
Tying line wires	156
UNBALANCE, improper transposition	271
Unbalance, longitudinal	270
Underground construction	191
Unloading flatcars	60
Unloading poles	57
Unloading poles, precautions	59

Page

V SLING 64
Vacuum-type arresters 209

WATER systems, as grounds 196
Water-jet method, pole setting 77
Waterway crossings 121, 122
Wire 216, 259
Wire, bridle, splicing 185
Wire, contact with other conductors 270
Wire, copper 216
Wire, drop, building fixtures 181
Wire, drop, connections 173
Wire, drop, construction 174
Wire, drop, on messenger cable 171
Wire, drop, splicing 185
Wire, galvanized iron 216
Wire, hanging 39
Wire, inside, splicing 185
Wire, line, dead-ending 164
Wire, line, electrical characteristics 261
Wire, line, physical characteristics 261
Wire, line, repair sleeves 272
Wire, loading 136
Wire, longitudinal unbalance 270
Wire, safety precautions 304
Wire, spacing, long span, pole line 94
Wire, splicing 41, 129
Wire, steel, copper-covered 217
Wire, stringing 37, 115
Wire stringing, parallel to power line 126
Wire stringing signals 119
Wires, dead-ending 163
Wires, line, tying 156
Wires, placing on poles 118
Working plans 18
Working up survey notes 23

AD-33 Bookplate
(1–63)

NATIONAL

AGRICULTURAL

LIBRARY

RMRS Library - Ogden

Library - Ogden Center
Rocky Mountain Research Station
324 25th Street
Ogden, UT 84401